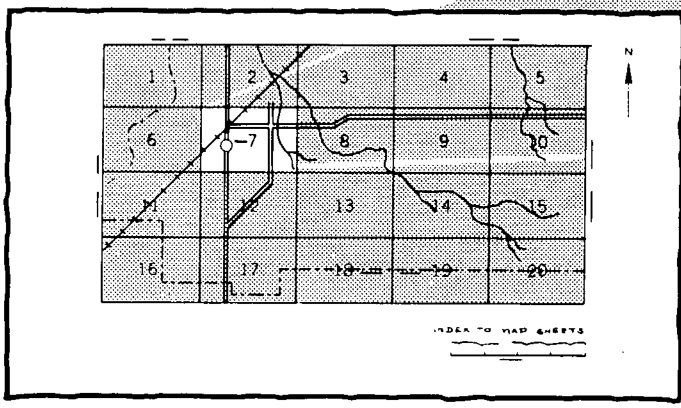
SOIL SURVEY OF

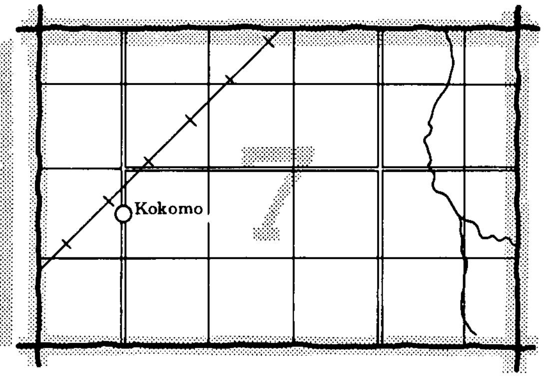
Antrim County, Michigan

U. S. Department of Agriculture
Soil Conservation Service
in cooperation with
Michigan Agricultural Experiment Station

HOW TO USE

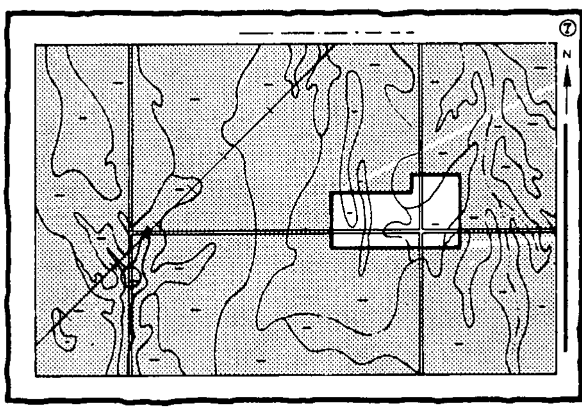
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

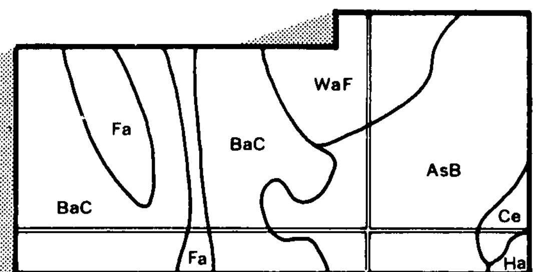




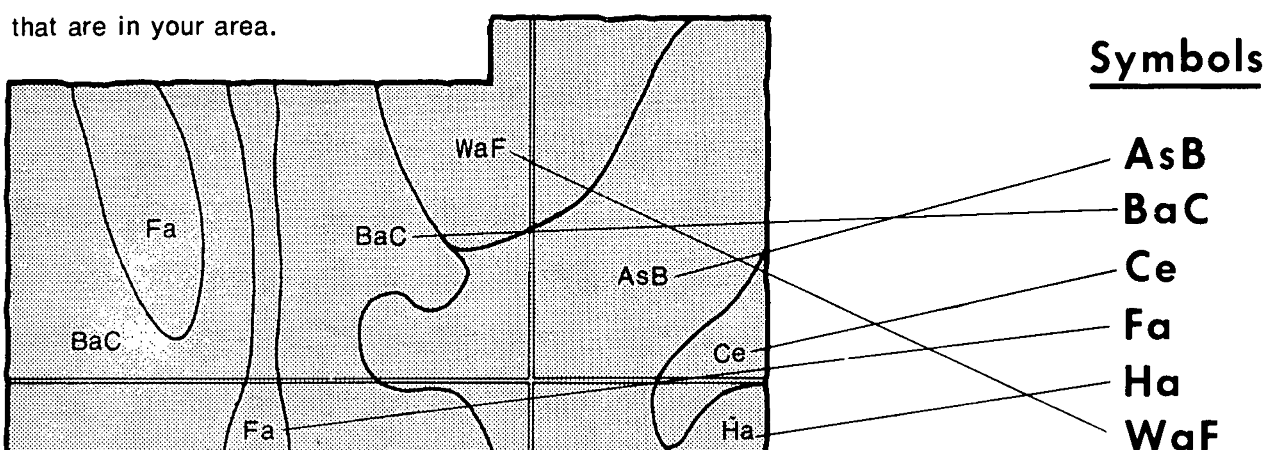
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



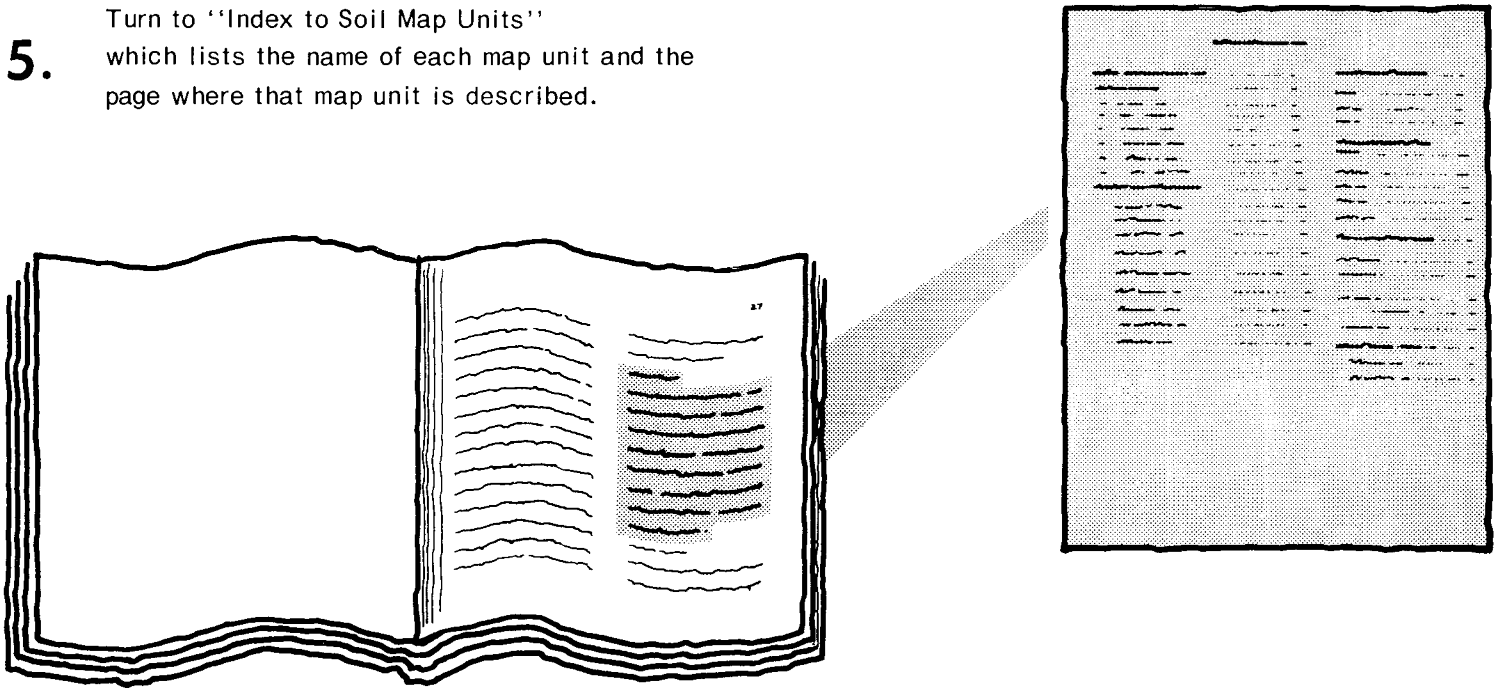


4. List the map unit symbols that are in your area.

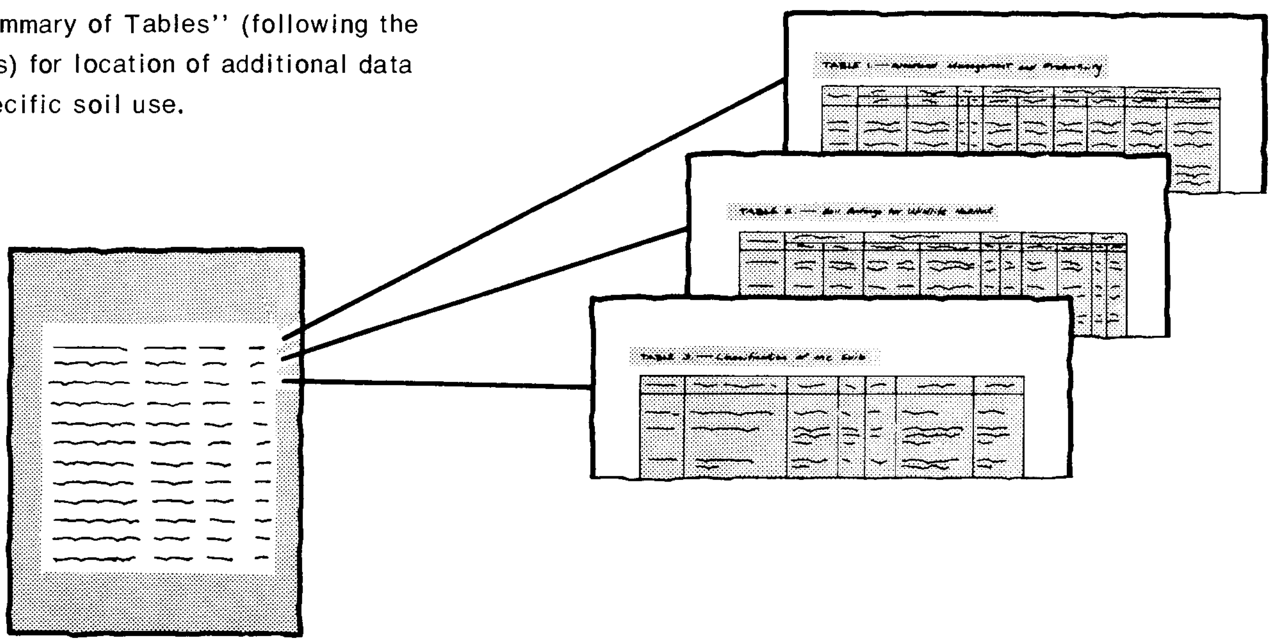


THIS SOIL SURVEY

5. Turn to ''Index to Soil Map Units'' which lists the name of each map unit and the page where that map unit is described.



6. See ''Summary of Tables'' (following the Contents) for location of additional data on a specific soil use.



7. Consult ''Contents'' for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1974-1976. Soil names and descriptions were approved in 1976. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Antrim Soil Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Typical landscape of Emmet-Montcalm complex, 3 to 12 percent slopes, in the western part of the county. Stripcropping is an important soil and water conservation practice on these soils.

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Issued December 1978

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Foreword

This soil survey contains much information useful in land-planning programs in Antrim County, Michigan. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

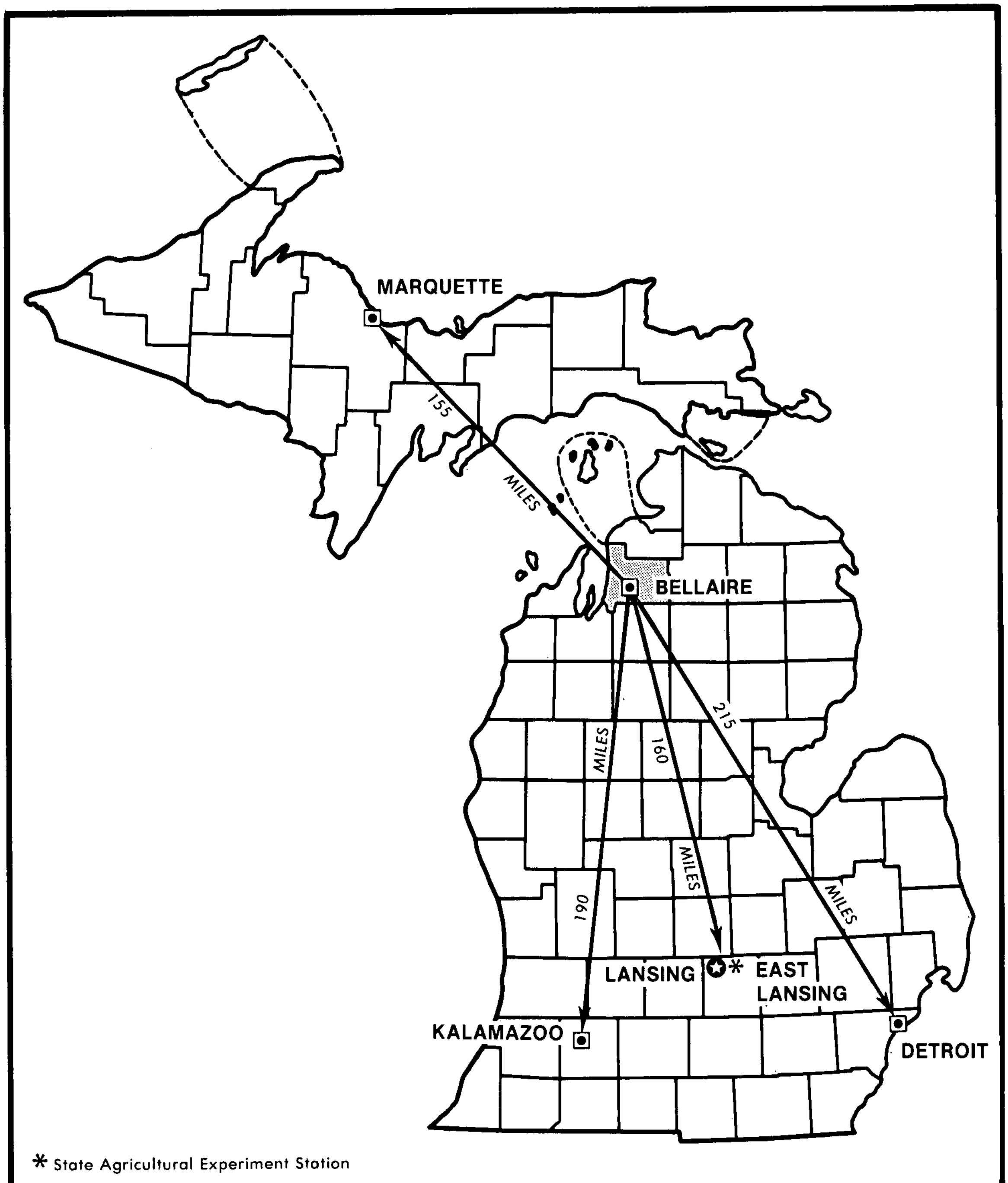
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Arthur H. Cratty
State Conservationist
Soil Conservation Service



Location of Antrim County in Michigan.

SOIL SURVEY OF ANTRIM COUNTY, MICHIGAN

By Richard L. Larson and
Donald E. Buchanan,
Soil Conservation Service

Fieldwork by Richard L. Larson
and Donald E. Buchanan,
Soil Conservation Service

U. S. Department of Agriculture, Soil Conservation Service,
in cooperation with the Michigan Agricultural Experiment Station

ANTRIM COUNTY is in the northwestern part of the lower peninsula of Michigan. The county is bordered on the north by Charlevoix County, on the east by Otsego County, on the south by Kalkaska and Grand Traverse Counties, and on the west by Grand Traverse Bay of Lake Michigan.

The county is 30 miles from east to west and 27 miles from north to south and has a land area of about 305,280 acres. Bellaire, the county seat, is in the west-central part of the county.

About 23 percent of the county is in farms. Large areas are in woods. The major crops are corn, oats, wheat, hay, several fruit crops, including apples and cherries, and potatoes. Livestock enterprises include dairy cows on some farms and beef cattle and turkeys on a few farms. Resort businesses, summer homes, and recreation uses contribute substantially to the economy of the county.

The villages of Central Lake, Elk Rapids, Ellsworth, and Mancelona are rural trading centers. The county has about 28,400 acres of inland water.

General nature of the county

This section gives general information about the climate of the county.

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at East Jordan for the period 1946 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22.6 degrees F, and the average daily minimum temperature is 14.7 degrees. The lowest temperature on record, which occurred at East Jordan on February 2, 1961, and again on February 26, 1963, is -31 degrees. In summer the average temperature is 65.7 degrees, and the average daily maximum temperature is 78.4 degrees. The highest recorded temperature, which occurred on August 5 and 6, 1947, is 100 degrees.

Growing degree days, shown in table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 18.8 inches, or 60 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 15.3 inches. The heaviest 1-day rainfall during the period of record was 3.59 inches at East Jordan on August 21, 1959. There are about 27 thunderstorms each year, and most occur in June and July.

Average seasonal snowfall is 89.9 inches. The greatest snow depth at any one time during the period of record was 37 inches. On the average, 120 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 66 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The percentage of possible sunshine is 65 in summer and 39 in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 12.4 miles per hour, in November.

Climatic data in this section were specially prepared for the Soil Conservation Service by the Michigan Department of Agriculture, Michigan Weather Service.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They

dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

1. Deer Park-Roscommon

Excessively drained, poorly drained, and very poorly drained, level to moderately steep, sandy soils on dunes and lake plains

This map unit consists mainly of gently sloping to moderately steep sand dunes between wet depressions on lake plains.

This unit makes up about 5 percent of the county. It consists of about 50 percent Deer Park or similar soils, 25 percent Roscommon or similar soils, and 25 percent minor soils.

Deer Park soils are gently sloping to moderately steep; they are on sand dunes and are excessively drained. The surface layer is light gray sand 9 inches thick. The subsoil and underlying material are multicolored loose sand.

Roscommon soils are nearly level in depressions between sand dunes. They are poorly and very poorly drained. Their surface layer is black mucky sand about 5 inches thick. The underlying material, to a depth of 60 inches, is multicolored loose sand.

The minor soils in this unit are the very poorly drained Tawas soils, poorly or very poorly drained Ensley soils, poorly drained Pickford soils, somewhat poorly drained Au Gres, Finch, and Iosco soils, moderately well drained Croswell soils, and somewhat excessively drained East Lake soils. The Tawas soils are intermingled with the Roscommon soils in the depressions between the dunes and in swamps and bogs. The Tawas soils and the Ensley soils are in larger depressions. The Pickford soils also are in depressions. The Au Gres, Finch, and Croswell soils are at the base of the sand dunes between the Deer Park and Roscommon soils and in slightly higher, broad, nearly level areas. The East Lake soils are in higher areas mostly on the outer edges of this map unit.

This unit is used mainly for woodland and for seasonal and year round homes. Wetness in the low areas and steepness in the dune areas are the main limitations to use for urban and woodland purposes.

This map unit has poor potential for cultivated crops, for intensive recreation use, and for residential and other urban uses. The excessively drained dune part has good potential for woodland production, and the poorly drained and very poorly drained areas have poor potential. The poorly drained and very poorly drained areas have good potential for wetland wildlife.

2. Emmet-Montcalm

Well drained and moderately well drained, gently sloping to very steep, loamy and sandy soils on knolls, ridges, and hills

This map unit consists mainly of undulating to steep areas on ridges and hills. There are several lakes and numerous drainageways and streams.

This unit makes up about 34 percent of the county. It consists of about 35 percent Emmet or similar soils, 35 percent Montcalm or similar soils, and 30 percent minor soils.

Emmet soils are undulating to very steep; they are on ridges and hills and are well drained and moderately well drained. They are on similar positions on the landscape as the Montcalm soils. Their surface layer is black sandy loam 4 inches thick. The subsurface layer is light brownish gray loamy sand 3 inches thick. The subsoil is about 34 inches thick. The upper part is reddish brown, friable sandy loam; the middle part is pinkish gray, very friable loamy sand and reddish brown, friable sandy loam; the lower part is reddish brown, friable sandy clay loam. The underlying material is light brown, friable sandy loam.

Montcalm soils are undulating to very steep on ridges and hills and are well drained. They are on similar positions on the landscape as the Emmet soils. The surface layer is pinkish gray loamy sand about 3 inches thick. The subsoil is about 46 inches thick. The upper part is multicolored, very friable loamy sand; the lower part consists of thin, interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

The minor soils in this unit are very poorly drained Tawas soils, poorly drained or very poorly drained Ensley soils, somewhat poorly drained Charlevoix, Chestonia, Iosco, and Kawkawlin soils, somewhat excessively drained Kalkaska soils, and well drained or moderately well drained Onaway soils. The Tawas and Ensley soils are in low, wet depressions between hills, in waterways, and by lakes. The Charlevoix, Iosco, and Kawkawlin soils are in depressions and on hilltops. The Chestonia soils are on hillsides, at the base of slopes and ridges, and on hilltops mostly in the north-central part of the county. The Kalkaska soils are intermingled with the Montcalm soils and are in the same position on the landscape as the Montcalm soils. The Onaway soils are mostly gently sloping to moderately sloping and are intermingled with the Emmet soils on hilltops.

This map unit is used mainly as cropland and woodland and for orchards. Much of the less sloping acreage has been cleared. Erosion, droughtiness, and steepness of slope are the main limitations for cropland use and for most other uses.

This unit has good potential for use as cropland, fair potential for intensive recreation and wildlife use, and good potential for sanitary facilities and community development purposes. It has good potential for use as woodland.

3. Tawas-Ensley-Roscommon

Very poorly drained and poorly drained, nearly level, mucky, loamy, and sandy soils in depressions on plains

This map unit consists of low, wet depressions on plains in long, broad valleys.

This unit makes up about 11 percent of the county. It consists of about 20 percent Tawas or similar soils, 20 percent Ensley or similar soils, 20 percent Roscommon or similar soils, and 40 percent minor soils.

Tawas soils are nearly level; they are in depressions, are adjacent to lakes and streams, and are very poorly drained. They are generally lower lying than the other soils in the unit. Their surface layer is black muck 16 inches thick. The subsoil is dark reddish brown muck about 15 inches thick. The underlying material is grayish brown sand.

Ensley soils are nearly level in depressions that are mainly adjacent to lakes and streams; they are poorly or very poorly drained. They are generally a little above the Tawas soils on the landscape. Their surface layer is very dark gray, mucky sandy loam about 8 inches thick. The subsoil is about 28 inches thick. The upper part is light brownish gray, mottled, very friable loamy sand; the middle part is brown, mottled, very friable sandy loam; the lower part is light reddish brown, mottled, firm loam. The underlying material, to a depth of 60 inches, is light brownish gray sandy loam and pale brown gravelly loamy sand.

Roscommon soils are nearly level; they are in depressions that are mainly adjacent to swamps, bogs, and streams; they are poorly drained or very poorly drained. They are generally a little above the Tawas soils on the landscape. Their surface layer is black mucky sand about 5 inches thick. The underlying material, to a depth of 60 inches, is multicolored loose sand.

The minor soils in this map unit are the poorly drained Pickford soils, somewhat poorly drained Au Gres and Finch soils, and moderately well drained Croswell soils. The Au Gres and Finch soils and the Croswell soils are on slightly higher islands intermingled with and on the outer edges of the major soils in depressions.

Nearly all areas of this unit are wooded. A few areas are used for hay and pasture. Soils of this unit have a high frost action potential.

This map unit has poor potential for cultivated crops, intensive recreation, woodland, sanitary facilities, and

community development. It has good potential for wetland wildlife and poor potential for openland wildlife and woodland wildlife.

4. Kalkaska-Montcalm

Somewhat excessively drained and well drained, nearly level to very steep, sandy soils on hills, ridges, and knolls

This map unit consists mainly of undulating to very steep areas on hills, ridges, and knolls. It is on the more hilly areas of the county. Valleys and small, wet depressions are scattered among the hills.

This unit makes up about 30 percent of the county. It consists of about 40 percent Kalkaska or similar soils, 30 percent Montcalm or similar soils, and 30 percent minor soils.

Kalkaska soils are nearly level to very steep; they are on the hills to low knolls and are somewhat excessively drained. They are in the same position on the landscape as the Montcalm soils. The surface layer is black sand 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

Montcalm soils are undulating to very steep; they are on hills and low ridges and are well drained. These soils are in the same positions on the landscape as the Kalkaska soils. The surface layer is pinkish gray loamy sand about 3 inches thick. The subsoil is about 46 inches thick. The upper part is multicolored, very friable loamy sand; the lower part consists of thin, interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

The minor soils in this map unit are very poorly drained Tawas soils, poorly drained to very poorly drained Ensley soils, somewhat poorly drained Chestonia soils, moderately well drained Croswell soils, well drained and moderately well drained Emmet soils, and somewhat excessively drained East Lake soils. The Ensley soils are in low, wet areas along streams and natural waterways. The Chestonia soils are on the hillsides mainly at the north end of the county. The Croswell soils are in valleys and at the base of hilly areas. The Emmet soils are on hillsides and on nearly level hilltops. The East Lake soils are on hillsides and in lower areas between the hills.

This map unit is used mainly as woodland. In some of the less sloping areas, it is used for crops. Two large ski resorts and accompanying real estate developments for homesites are in this unit. Steepness of slope and droughtiness are the main problems for cropland. Steepness of slope is the main limitation for intensive recreation, urban, and woodland uses.

This map unit has fair to poor potential for cultivated crops. It has fair potential for intensive recreation development, wildlife use, sanitary facilities, and community development. It has good to fair potential for woodland.

5. Kalkaska-East Lake-Karlin

Somewhat excessively drained, level to very steep, sandy soils on plains

This map unit consists mainly of level or nearly level to gently sloping areas on plains (fig. 1). It includes some steep slopes around depressions.

This unit makes up about 20 percent of the county. It consists of about 50 percent Kalkaska or similar soils, 20 percent East Lake or similar soils, 20 percent Karlin or similar soils, and 10 percent minor soils.

Kalkaska soils are mostly nearly level to gently sloping, but they range to very steep in the depressions. These soils are somewhat excessively drained. They are mostly in the same position on the landscape as the East Lake and Karlin soils. The surface layer is black sand 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

East Lake soils are mostly nearly level to gently sloping, but they range to very steep in some of the depressions and are somewhat excessively drained. They are mostly in the same position on the landscape as the Kalkaska soils. The surface layer is very dark gray gravelly loamy sand 7 inches thick. The subsoil is about 19 inches thick. The upper part is yellowish red and dark reddish brown, very friable gravelly loamy sand. The lower part is yellowish brown loose sand. The underlying material, to a depth of 60 inches, is multicolored stratified sand and gravel.

Karlin soils are mostly nearly level to gently sloping, but they range to very steep in some of the depressions and are somewhat excessively drained. They are mostly in the same position on the landscape as the Kalkaska soils. The surface layer is gray loamy fine sand about 3 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown and dark brown, very friable loamy fine sand; the lower part is brown, loose loamy sand. The underlying material is light yellowish brown loose sand.

The minor soils in this map unit are somewhat poorly drained Au Gres and Finch soils and somewhat excessively drained to excessively drained Rubicon soils. The Au Gres and Finch soils are in seasonally wet depressions widely scattered in this unit. The Rubicon soils are intermingled with the major soils and are in a larger, nearly level area in the southeast corner of the county.

This map unit is used mainly as woodland and for potatoes. Droughtiness and soil blowing are the main problems for use as cropland. There are few limitations for most other uses.

This unit has fair potential for cultivated crops, for intensive recreation use, for sanitary facilities, and for community development. It has good to fair potential for woodland and poor potential for wildlife.

Broad land use considerations

Each year a considerable amount of land is being developed for residential use throughout the county. The general soil map is most helpful in planning the general locations for residential development; it cannot be used for the selection of sites for specific residential or urban structures. In general, in the survey area the soils that have good potential for cultivated crops also have good potential for residential development. The data about specific soils in this survey can be helpful in planning future land use patterns.

Areas where the soils have severe limitations for residential and other urban development are extensive. A large part of the Deer Park-Roscommon map unit and the Tawas-Ensley-Roscommon unit has a seasonal high water table, which is a severe limitation in urban development. The more sloping parts of the Deer Park-Roscommon map unit, the Emmet-Montcalm unit, and the Kalkaska-Montcalm unit also have severe limitations for urban development.

There are also large areas of soils in the county that can be developed for urban uses. These include the less sloping parts of the Deer Park-Roscommon map unit, the Emmet-Montcalm map unit, the Kalkaska-Montcalm map unit, and the Kalkaska-East Lake-Karlin map unit. The Emmet-Montcalm unit has the best potential for use as cropland, and this potential should not be overlooked when broad land uses are considered.

In some areas there are soils that have good potential for farming and poor potential for nonfarm uses. The Ensley part of the Tawas-Ensley-Roscommon map unit is an example. Wetness is a limitation of the Ensley soil to farm and nonfarm uses. But with proper drainage and shaping of the surface, the soil has good potential for farming, and some farmers have provided sufficient drainage for farm crops.

The less sloping, well drained soils of the Emmet-Montcalm map unit that have good air drainage are uniquely suited to tree fruits, especially red tart cherries.

Most of the soils of the county have good or fair potential for use as woodland. Notable exceptions are the soils of the Tawas-Ensley-Roscommon map unit on which trees do not grow naturally or produce poor wood crops. Commercially valuable trees are less common and generally do not grow so rapidly on the wetter soils of the Deer Park-Roscommon map unit as they do on the soils in the other units.

The hilly parts of the Emmet-Montcalm and Kalkaska-Montcalm map unit have good potential as sites for parks and extensive recreation areas. Hardwood forests enhance the beauty of much of these units. Undrained marshes and swamps of the Tawas-Ensley-Roscommon and Deer Park-Roscommon units are good as nature study areas. All these units provide habitat for many species of wildlife.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Chestonia series, for example, was named for the township of Chestonia in Antrim County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Kalkaska sand, 0 to 6 percent slopes, is one of several phases within the Kalkaska series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes, for example, Tawas-Ensley complex.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Au Gres-Finch sands, 0 to 4 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit.

Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Beaches is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

AuA—Au Gres-Finch sands, 0 to 4 percent slopes. This map unit consists of nearly level and gently sloping, somewhat poorly drained soils in depressions and in areas adjacent to bogs. The areas are 5 to 40 acres or more in size and are made up of about 50 percent Au Gres sand, 30 percent Finch sand, and 20 percent other soils. The Au Gres and Finch soils are so intermingled that they were not separated in mapping.

Typically, the Au Gres soil has a black and pinkish gray sand and organic duff surface layer about 1 inch thick and a pinkish gray sand subsurface layer about 5 inches thick. The subsoil and underlying material are multicolored, loose or very friable sand.

Typically, the Finch soil has a surface layer of black sand about 2 inches thick. The subsurface layer, about 10 inches thick, is light gray and light brownish gray, mottled sand. The subsoil is about 26 inches thick. The upper part is multicolored, strongly cemented sand, and the lower part is dark yellowish brown, mottled, loose sand. The underlying material, to a depth of 60 inches, is multicolored, loose sand.

Included with these soils in mapping are intermingled areas, generally less than 1 acre in size, of poorly drained and very poorly drained Roscommon soils in wet depressions and swales and somewhat excessively drained Kalkaska soils on low ridges. These soils make up about 20 percent of this map unit.

Permeability is rapid in the Au Gres soil; it is slow in the Finch soil because of the cemented sand in the upper part of the subsoil. The available water capacity is very low in the Finch soil and low in the Au Gres soil. Runoff is slow on both soils. The seasonally high water table is within 1/2 to 1 1/2 feet of the surface in winter and spring.

Most areas remain in woodland or are idle. A few areas are in crops or pasture. This map unit has fair potential for cultivated crops and good potential for pasture. It has fair to poor potential for woodland. It has poor potential for campsite development, fair potential for picnic areas, and poor potential for playgrounds and paths and trails. The potential for most engineering uses is poor.

The main management problem for cultivated crops and pasture is excess water during part of the growing season. Artificial drainage, using tile and open ditches, helps to lower the water table. The very low or low available water capacity often causes droughty conditions after the water table has been lowered. Soil blowing is a hazard that can be controlled by stripcropping or a permanent vegetative cover. The cemented subsoil of the Finch soil restricts rooting depth and downward movement of water. A subsoiler can break up this cemented layer and improve permeability.

The management problems for woodland are equipment limitations, seedling mortality, and windthrow hazard. The use of equipment should be confined to the driest time of the year. Seedling mortality is high; replanting may be necessary. In harvesting woodland, a cutting system should be used that results in minimum residual stands—for example, group selection, seed trees, and clear cutting. Also, planting in furrows helps to reduce plant competition.

The seasonally high water table adversely affects sanitary facilities and community development. Surface ditches and tile can be used to lower the water table in areas selected for community development. Sewage lagoons are affected by rapid seepage. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used and excess water should be removed. Capability subclass IVw; Michigan soil management group (5b, 5b-h).

Be—Beaches. This nearly level and gently sloping miscellaneous area consists of loose sandy and stony lake beaches and strands. The soil materials have not been in place long enough to have developed a profile. The areas are only a few feet above the present level of Lake Michigan (fig. 2).

Included in mapping are intermingled areas, about 1/2 acre in size, of Deer Park and Roscommon soils.

Beaches are generally idle. Their potential use is for recreation and esthetic purposes. Soil blowing and wave erosion are serious hazards. (Not placed in a capability subclass or Michigan soil management group.)

CbA—Charlevoix sandy loam, 0 to 4 percent slopes. This is a nearly level and gently sloping, somewhat poorly drained soil in depressions on uplands. The areas are commonly 5 to 20 acres or more in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is light brownish gray, mottled loamy sand about 2 inches thick. The subsoil is dark reddish brown and brown, mottled, friable sandy loam about 22 inches thick. The under-

lying material, to a depth of 60 inches, is pale brown, mottled sandy loam and gravelly sandy loam. The subsoil and underlying material are finer textured in some areas.

Included with this soil in mapping are intermingled areas of well drained and moderately well drained Emmet and Onaway soils and well drained Montcalm soils on low ridges. Poorly drained to very poorly drained Ensley soils are in depressions. These included soils make up as much as 15 percent of this map unit.

Permeability is moderate or moderately rapid. The available water capacity is moderate, and runoff is slow. The seasonally high water table is within about 1/2 to 1 1/2 feet of the surface in winter and spring.

Most areas of this soil are in crops, pasture, or woodland. A few areas are idle. This soil has good potential for cultivated crops, pasture, and woodland. It has poor potential for camp areas and playgrounds and fair potential for picnic areas and paths and trails. The potential for most engineering uses is poor.

The main management problem for cultivated crops is excess water in the soil. Adequate artificial drainage is needed for crop production. Tile and shallow field ditches that have adequate outlets help to lower the water table. Frost is a hazard on this soil. Short-season crops should be planted. Shallow field ditches can relieve the excess water problem for pasture use.

The main management problem on woodland is plant competition. Planting sites should be intensively prepared and maintained.

The seasonally high water table adversely affects sanitary facilities and community development. There is frost action on local roads and streets. The upper layer of the soil should be replaced or covered with suitable base material so local roads and streets will function properly. Surface ditches or tile, or both, should be used to lower the water table in areas of community development. Capability subclass IIw; Michigan soil management group (3b).

CcB—Chestonia silty clay loam, 3 to 12 percent slopes. This gently sloping and moderately sloping, somewhat poorly drained soil is on uplands. It is on ridgetops and foot slopes that are irregularly shaped and are 10 to about 80 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 4 inches thick. The subsoil is about 12 inches thick. The upper part is dark grayish brown, mottled, very firm silty clay loam. The lower part is mottled dark grayish brown and light yellowish brown, firm clay loam. The underlying material is gray, mottled, shaly silty clay.

Included with this soil in mapping are intermingled areas of well drained and moderately well drained Emmet soils, well drained Montcalm soils, and somewhat excessively drained Kalkaska soils. Wet depressions and waterways occur randomly in most areas. These included soils make up about 10 to 15 percent of this map unit.

Permeability is very slow, and available water capacity is moderate. Runoff is rapid. The seasonally high water table is within 1 to 2 feet of the surface in winter and spring.

Most areas of this soil are in woodland or pasture. A few areas are in crops or are idle. This soil has fair potential for cultivated crops, good potential for pasture, and good potential for woodland. It has fair potential for picnic areas and paths and trails and poor potential for camp areas and playgrounds. The potential for most engineering uses is poor.

The main management problems if this soil is used as cropland are erosion and very slow permeability, which makes adequate drainage of the soil difficult. Stripcropping, minimum tillage, and leaving crop residues on the surface reduce the erosion hazard. Surface ditches and tile reduce the wetness problem.

Soil wetness, very slow permeability, and soil compaction are management problems if this soil is used for pasture. Use water-tolerant grasses and legumes and do not pasture when the soils are wet.

Management problems if this soil is used as woodland are equipment limitations imposed by soil wetness and poor trafficability. Plant competition can be reduced by cultivation and selective spraying.

Sanitary facilities and community development are adversely affected by slow percolation, wetness, and slope. Septic tank absorption fields will not function properly because of slow percolation and wetness. Surface ditches and tile can be used to reduce wetness. Landforming can reduce the problems caused by steepness of slope. Capability subclass IIIe; Michigan soil management group (1b).

CcD—Chestonia silty clay loam, 12 to 40 percent slopes. This strongly sloping to very steep, somewhat poorly drained soil is on uplands. It is on the side slopes of hills. Areas are commonly 40 to 100 acres or more in size.

Typically, the surface layer is very dark gray silty clay loam about 4 inches thick. The subsoil is about 12 inches thick. The upper part is dark grayish brown, mottled, very firm silty clay loam. The lower part is mottled dark grayish brown and light yellowish brown, firm clay loam. The underlying material is gray, mottled, shaly silty clay.

Included with this soil in mapping are intermingled areas of well drained or moderately well drained Emmet, well drained Montcalm, and somewhat excessively drained Kalkaska soils. Wet depressions, waterways, and gullies are in most areas. Springy conditions exist in many of the gullies. The included soils make up 10 to 15 percent of this map unit.

Permeability is very slow, and the available water capacity is moderate in this soil. Runoff is rapid. The seasonally high water table is within 1 to 2 feet of the surface in winter and spring.

Most areas of this unit are in woodland. A few areas are in pasture or are idle. This map unit has poor potential for cultivated crops, fair potential for pasture, and good potential for woodland. Its potential for recreation uses such as camp areas, picnic areas, playgrounds, and paths and trails is poor. The potential for engineering uses also is poor.

Management problems for pasture include soil wetness and steep slopes. Water-tolerant forage plants should be used. Restricted grazing during wet periods helps reduce soil compaction.

Management problems for woodland, imposed by the steep slopes and very slow permeability, include an erosion hazard, equipment limitations, seedling mortality, and plant competition. Logging roads should be located with care to reduce erosion. The use of heavy equipment should be confined to the driest time of the year. Seedling mortality is medium, but some areas may need replanting. Plant competition can be reduced by cultivation and selective spraying.

Sanitary facilities and community development are adversely affected by the steepness of the slopes. Slow percolation, wetness, and a high content of clay are other problems. Land forming in some places can flatten the slopes for building. Roads and streets should be constructed on the contour where slopes are a problem. Areas that are too clayey for sanitary landfills should be covered or mixed with suitable material. Capability subclass VIe; Michigan soil management group (1b).

CdA—Croswell sand, 0 to 4 percent slopes. This is a nearly level and gently sloping, moderately well drained soil on lowlands. It is mainly in shallow depressions or adjacent to stream channels or bogs and swamps. Areas are commonly 10 to 40 acres or more in size.

Typically, the surface layer is black sand about 1 inch thick. The subsurface layer is pinkish gray sand about 5 inches thick. The subsoil is about 24 inches thick. The upper part is dark reddish brown and reddish brown, very friable sand. The lower part of the subsoil and the underlying material, to a depth of 60 inches, are multicolored loose sand.

Included with this soil in mapping are intermingled areas of somewhat excessively drained Kalkaska soils on low mounds and somewhat poorly drained Au Gres and Finch soils in wet swales. These included soils make up about 10 percent of this map unit.

Permeability is rapid, and the available water capacity is low. Runoff is very slow. The seasonally high water table is within 2 to 3 feet of the surface in winter and spring.

Most areas remain in woodland or are idle. A few areas are in crops and pasture or are used for houses. This soil has good potential for woodland and pasture and fair potential for cultivated crops. Its potential for recreation uses such as camp areas and picnic areas is fair, and for playgrounds and paths and trails the potential is poor. The potential for most engineering uses is poor.

Soil blowing and drought are hazards for cultivated crops and pasture. The surface soil can be protected from blowing by using stripcropping, minimum tillage, crop residues on the surface, or permanent vegetation. Management that increases the organic matter content by use of green manure crops, barnyard manure, and long rotation in grass can help increase the available water capacity to lessen the droughty condition. Restricting grazing during dry periods will help protect pasture from being overused and depleted.

Woodlands managed for red pine, jack pine, and quaking aspen do not require special measures.

The seasonally high water table from about November to April adversely affects community development and sanitary facilities. The soil is too wet for use as septic tank absorption fields. Conditions that cause wet basements can be alleviated by using surface ditches or tile to lower the water table. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used and excess water should be removed. Sewage lagoons are affected by excess seepage and wetness. Sealing the lagoon with impervious material helps to correct the seepage problem, and use of surface ditches and tile lessens the wetness problem. Capability subclass IVs; Michigan soil management group (5a).

DeC—Deer Park sand, 2 to 20 percent slopes. This gently sloping to moderately steep, excessively drained soil is on ridges adjacent to Lake Michigan on the western side of the county. Areas are commonly irregularly shaped and more than 10 acres in size.

Typically, the surface layer is light gray sand about 9 inches thick. The subsoil and underlying material are multicolored loose sand.

Included with this soil in mapping are intermingled areas of the moderately well drained Croswell soil on the lower slopes of sand dunes and somewhat poorly drained Au Gres and Finch soils and poorly drained and very poorly drained Roscommon and Tawas soils in wet depressions between dunes. These soils make up about 15 percent of this map unit.

Permeability of this soil is rapid, and the available water capacity is low. Runoff is slow.

Most areas of this soil are woodland, and a few areas are used for houses. This soil has poor potential for cultivated crops and pasture. The potential for use as woodland is good. Its potential for recreation uses such as camp areas and picnic areas is fair to poor, and for playgrounds and paths and trails the potential is poor. The potential for most engineering uses is fair.

The droughty conditions and steepness of slope are problems for woodland use. The high seedling mortality is another management problem. Logging roads should be located with care to reduce erosion. Because seedling mortality is high, replanting may be necessary.

Sewage lagoons are affected by rapid seepage. Sealing the lagoon with impervious material helps to correct the problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. The steepness of slope on much of this soil is the main limitation for sanitary facilities and community development. Because of the rapid permeability, water supplies can become polluted. Capability subclass VIIs; Michigan soil management group (5.3a).

DrC—Deer Park-Roscommon complex, 0 to 20 percent slopes. This map unit consists of gently sloping to moderately steep, excessively drained Deer Park soils on

ridges and nearly level, poorly drained and very poorly drained Roscommon soils in swales between the ridges on the plains adjacent to Lake Michigan. The Roscommon soils are flooded frequently.

Individual areas of this map unit are 80 to 200 acres or more in size and are made up of 40 to 60 percent Deer Park soils and 25 to 30 percent Roscommon soils. These soils occur in a regular pattern, but the areas of the individual soils are too narrow to separate in mapping.

Typically, Deer Park soils have a surface layer of light gray sand about 9 inches thick. The subsoil and underlying material are multicolored loose sand.

Typically, Roscommon soils have a black mucky sand surface layer about 5 inches thick. The underlying material, to a depth of 60 inches, is multicolored loose sand. The surface layer is sand in some areas.

Included with these soils in mapping are intermingled areas of moderately well drained Croswell soils and somewhat poorly drained Au Gres soils on the lower side slopes of the ridges and on low hummocks in the swales. Very poorly drained Tawas muck is in some swales. These included soils make up about 10 percent of this map unit.

Permeability is rapid, and the available water capacity is low. Runoff is slow on Deer Park soils and very slow and ponded on Roscommon soils. In areas of Roscommon soils, the seasonally high water table is at the surface or within 1 foot of the surface from fall through spring.

Most areas of this map unit are woodland, and a few areas are used for houses. The potential for cultivated crops is poor. The potential for pasture is fair on the Roscommon soils and poor on the Deer Park soils. The potential for woodland is good on the Deer Park soils and poor on the Roscommon soils. The potential for development of camp areas, playgrounds, and paths and trails is poor, and the potential for picnic areas is fair on the Deer Park soils and poor on the Roscommon soils. The potential for most engineering uses is fair.

The main management problems for woodland are equipment limitations and windthrow hazard in wet areas and seedling mortality and plant competition in all areas. Heavy equipment should be used during the driest part of the year in the wet areas. Clear cutting in the wet areas during harvest will reduce the windthrow hazard. Seedling mortality is high; replanting may be necessary. Plant competition can be controlled by spraying and planting in furrows.

Sanitary facilities and community development are adversely affected by the high water table and frequent flooding on the Roscommon soils. Septic tank absorption fields should not be used in the wet areas. Slopes of more than 8 percent on the Deer Park soils are a problem if the soils are used as septic tank absorption fields. Seepage is an additional problem if the soils are used for sewage lagoons. Retaining walls should be used in shallow excavations to prevent the cutbanks from caving in. Capability subclass VIIs; Michigan soil management group (5.3a-5c).

EaB—East Lake gravelly loamy sand, 0 to 6 percent slopes. This nearly level and gently sloping, somewhat excessively drained soil is on terraces or ridgelike positions on broad plains and at the base of adjacent steep hills. This soil is also on the higher parts of terraces adjacent to lakes. Areas are commonly 10 to 40 acres or more in size.

Typically, the surface layer is very dark gray gravelly loamy sand about 7 inches thick. The subsoil is about 19 inches thick. The upper part is yellowish red and dark reddish brown, very friable gravelly loamy sand. The lower part is yellowish brown loose sand. The underlying material, to a depth of 60 inches, is multicolored stratified sand and gravel. The upper part of the subsoil is darker colored and not so thick in some areas.

Included with this soil in mapping are intermingled areas of somewhat excessively drained Kalkaska soils or somewhat excessively drained to excessively drained Rubicon soils and soils that have a finer textured subsoil. Wet depressions and swales are in some areas. These included soils make up 10 to 15 percent of this map unit.

Permeability is rapid, and the available water capacity is very low. Runoff is slow.

Most areas of this soil are in woodland or are idle, but a few areas are in crops or pasture or are used for houses. This soil has fair potential for cultivated crops and woodland and good potential for pasture. Its potential for recreation uses such as camp areas and picnic areas is fair, and for playgrounds and paths and trails the potential is poor. The potential for most engineering uses is fair.

Soil blowing and drought are hazards for cultivated crops. Stripcropping, minimum tillage, leaving crop residues on the surface, or permanent vegetation keep the surface soil from blowing. Increasing the organic matter content by use of green manure crops, barnyard manure, and long rotation in grass will increase the water supplying capacity and lessen the droughty condition. Restricting grazing during dry periods helps protect pasture from being overused and depleted.

Seedling mortality is the major management problem in woodlands. Replanting of seedlings may be necessary.

The main problem for sanitary facilities is rapid seepage in sewage lagoons. Seepage may be stopped by sealing these areas with impervious material. A seasonally high water table in some depressions and swales causes a wetness problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Wet basements are a problem in depressions and swales. Using tile drains or surface ditches lowers the water table. Because of rapid permeability and the seasonally high water table in some areas, water supplies can become polluted. Capability subclass IVs; Michigan soil management groups (5a).

EmB—Emmet-Montcalm complex, 3 to 12 percent slopes. This map unit consists of gently sloping and moderately sloping, well drained and moderately well drained soils on upland hilltops. Drainageways and

steeply sloping areas dissect many areas of these soils. Individual areas range from 40 to 100 acres or more in size and are made up of about 40 percent Emmet soils and 40 percent Montcalm soils. These soils are so intricately mixed that they were not separated in mapping.

Typically, the Emmet soils have a surface layer of black sandy loam about 4 inches thick. The subsurface layer is light brownish gray loamy sand about 3 inches thick. The subsoil is about 34 inches thick. The upper part is reddish brown, friable sandy loam. The middle part is pinkish gray, very friable loamy sand and reddish brown, friable sandy loam. The lower part is reddish brown, friable sandy clay loam. The underlying material is light brown, friable sandy loam.

Typically, the Montcalm soils have a surface layer of pinkish gray loamy sand about 3 inches thick. The subsoil is about 46 inches thick. The upper part is multicolored, very friable loamy sand; the lower part is thin, interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

Included in mapping are intermingled areas of somewhat excessively drained, sandy Kalkaska soils and somewhat excessively drained to excessively drained Rubicon soils at the same elevation as Emmet and Montcalm soils and somewhat poorly drained Charlevoix soils and poorly drained or very poorly drained Ensley soils in wet depressions and waterways. Also included are some small areas of steep soils. These included soils make up about 20 percent of this map unit.

Permeability is moderate in the Emmet soils and rapid in the Montcalm soils. The available water capacity of these soils is moderate. Runoff is medium. Where Emmet soils are moderately well drained, the seasonally high water table is within 2 1/2 to 4 feet of the surface in winter and spring.

Most areas of this map unit are in crops, orchards, pasture, or woodland, and a few areas are idle or are used for houses. This map unit, in the western part of the county, is well suited to red tart cherries. The soils have fair potential for cultivated crops and good potential for pasture and woodland. The potential for recreation uses such as camp areas, picnic areas, and paths and trails is good, and the potential for playgrounds is fair. The potential for most engineering uses is good.

The main management problems are erosion and droughty conditions. Long rotations in grass and use of green manure crops help increase the organic matter content and the available water capacity, and they lessen the droughty condition. Minimum tillage, leaving crop residues on the surface, contour stripcropping (fig. 3), and long rotations in grass help control erosion. Restricting grazing during dry periods decreases the damage to pasture.

Plant competition and seedling mortality are the main management problems on woodland. Selective spraying and planting in furrows help reduce plant competition. Replanting of seedlings may be necessary.

Slope is the main problem in using the soils as septic tank absorption fields. Seepage and slope are the main problems for sewage lagoons. There is a possible pollution hazard to water supplies from sanitary facilities because of the rapid permeability of the Montcalm soils. To prevent cutbanks in shallow excavations in the Montcalm soils from caving in, retaining walls should be used. Community development is affected by the slope. Land forming can help correct the problem. Roads and streets should be constructed on the contour. Capability subclass IIIe; Michigan soil management group (3a-4a).

EmD—Emmet-Montcalm complex, 12 to 40 percent slopes. This map unit consists of strongly sloping to steep and very steep, well drained and moderately well drained soils on uplands. These soils are mainly on the side slopes of hills. Individual areas are 40 to 100 acres or more in size and are made up of 30 to 40 percent Emmet soils and 30 to 40 percent Montcalm soils. These soils are so intricately mixed that they were not separated in mapping.

Typically, Emmet soils have a surface layer of black sandy loam about 4 inches thick. The subsurface layer is light brownish gray loamy sand about 3 inches thick. The subsoil is about 34 inches thick. The upper part is reddish brown, friable sandy loam. The middle part is pinkish gray, very friable loamy sand and reddish brown, friable sandy loam. The lower part is reddish brown, friable sandy clay loam. The underlying material is light brown, friable sandy loam. The lower part of the subsoil and underlying material are mottled in some areas.

Typically, the Montcalm soils have a surface layer of pinkish gray loamy sand about 3 inches thick. The subsoil is about 46 inches thick. The upper part is multicolored, very friable loamy sand. The lower part consists of thin, interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

Included with these soils in mapping are intermingled areas of somewhat excessively drained Kalkaska soils, somewhat excessively drained to excessively drained Rubicon soils, and well drained or moderately well drained Onaway soils at the same elevation as the Emmet and Montcalm soils. Onaway soils have more clay in the subsoil. Somewhat poorly drained Charlevoix soils and poorly drained or very poorly drained Ensley soils are in wet depressions and waterways. These included soils make up 15 to 25 percent of this map unit.

Permeability is moderate in the Emmet soils and rapid in the Montcalm soils. The available water capacity of these soils is moderate. Runoff is medium. Where Emmet soils are moderately well drained, the seasonally high water table is within 2 1/2 to 4 feet of the surface in winter and spring.

Most areas of this map unit are in pasture (fig. 4), woodland, or are idle. A few areas are in crops or are used for houses. This map unit has poor potential for cultivated crops, fair potential for pasture, and good potential for woodland. Its potential is poor for such recreation uses as camp areas, picnic areas, paths and trails, and

playgrounds. The potential for most engineering uses is also poor.

The main management problem is erosion. Restricting grazing during dry periods decreases the damage to pasture.

The management problems on woodland are the erosion hazard, equipment limitation, seedling mortality, and plant competition. Logging roads should be located with care to reduce erosion. Replanting of seedlings may be necessary. Selective spraying and planting in furrows help to reduce plant competition.

Sanitary facilities and community development are adversely affected by the steepness of the slopes. Land forming is needed. Roads and streets should be built on the contour. Seepage is another problem in sewage lagoons. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations in the Montcalm soils from caving in, retaining walls are needed. Replacing or covering the upper layers of soil material with a suitable base material is necessary so that local roads and streets are not damaged by frost action. Because of the rapid permeability of the Montcalm soils, water supplies can become polluted. Capability subclass VIe; Michigan soil management group (3a-4a).

EoB—Emmet-Onaway sandy loams, 3 to 12 percent slopes. This map unit consists of gently sloping and moderately sloping, well drained and moderately well drained soils on upland ridgetops. Steep areas dissect many areas of these soils. Individual areas are 40 to 100 acres or more in size and are made up of about 50 percent Emmet soils and 30 percent Onaway soils. These soils are so intricately mixed that they were not separated in mapping.

Typically, Emmet soils have a black sandy loam surface layer about 4 inches thick. The subsurface layer is light brownish gray loamy sand about 3 inches thick. The subsoil is about 34 inches thick. The upper part is reddish brown, friable sandy loam. The middle part is pinkish gray, very friable loamy sand and reddish brown, friable sandy loam. The lower part is reddish brown, friable sandy clay loam. The underlying material is light brown, friable sandy loam.

Typically, Onaway soils have a very dark grayish brown sandy loam surface layer about 8 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown and brown, very friable fine sandy loam. The lower part is reddish brown, firm clay loam. The underlying material is light brown, firm loam.

Included with these soils in mapping are intermingled areas of somewhat excessively drained Kalkaska soils and well drained Montcalm soils. Somewhat poorly drained Charlevoix soils and poorly drained to very poorly drained Ensley soils are in wet swales and waterways. Also included are areas of steep soils. These included soils make up about 15 percent of this map unit.

Permeability is moderate in the Emmet soils and moderate or moderately slow in the Onaway soils. The available water capacity is moderate in the Emmet soils and high in the Onaway soils. Runoff is medium. Where the Emmet or Onaway soils are moderately well drained, the seasonal high water table is within 2 1/2 to 4 feet of the surface in winter and in spring.

Most areas of this map unit are in crops, pasture, or woodland. A few areas are in orchards or are used for houses. The seasonally high water table and moderate or moderately slow permeability of the soils greatly reduce yields of red tart cherries. This unit has good potential for cultivated crops, pasture, and woodland. Its potential for recreation uses such as camp areas and picnic areas is good, and the potential for playgrounds and paths and trails is fair. The potential for most engineering uses is good.

The main management problem is erosion (fig. 5). Contour stripcropping, leaving crop residues on the surface, long rotations in grass, and minimum tillage are management practices that can be used to reduce erosion. Wetness is a problem in some areas. Shallow field ditches and tile are needed in the wet areas to lower the water table for cultivation in the spring.

Plant competition is the main management problem for woodland. Selective spraying and planting in furrows will reduce plant competition.

Sanitary facilities and community development are adversely affected by the slopes. Land forming is needed for sewage lagoons because of the slopes. Seepage is a problem in some places. Those areas should be sealed with impervious material. Where there is a seasonally high water table, water supplies can become polluted. Frost action is a problem for local roads and streets. Shrink-swell is a problem on the Onaway soils. Proper design of foundations and footings is necessary to prevent structural damage. Replacing or covering the upper layers of soil material with a suitable base material is necessary so local roads and streets will function properly. Houses and small buildings should be constructed without basements; foundations should be backfilled with suitable material and drainage around the foundations should be provided. Capability subclass IIe; Michigan soil management group (3a-2.5a).

IoA—Iosco sand, 0 to 4 percent slopes. This nearly level and gently sloping, somewhat poorly drained soil is in upland depressions. Flooding is unlikely, but it does occur when there are unusual weather conditions. The areas are commonly 10 to 40 acres in size.

Typically, the surface layer is black sand about 3 inches thick. The subsurface layer is light brownish gray, mottled sand about 6 inches thick. The subsoil is about 16 inches thick. The upper part is dominantly multicolored, very friable sand; the lower part is brown, mottled, firm silty clay loam. The underlying material is brown, mottled, firm clay loam.

Included with this soil in mapping are intermingled areas of very poorly drained soils in depressions and of the less sandy, somewhat poorly drained Kawkawlin soils at the same elevation. These included soils make up 10 to 15 percent of this map unit.

Permeability is rapid in the sandy upper part and moderately slow in the loamy lower part. The available water capacity is moderate. Runoff is slow. The seasonally high water table is within 1 to 2 feet of the surface from fall through spring.

Most areas of this soil are woodland or pasture or are idle; a few areas are cropland. This soil has fair potential for cultivated crops and woodland and good potential for pasture. Its potential for recreation uses such as camp areas and playgrounds is poor; for picnic areas and paths and trails the potential is fair. The potential for most engineering uses is poor.

The main management problem for cultivated crops is excess water in the soil. Artificial drainage using tile and shallow field ditches is needed to lower the water table. Soil blowing, drought, and frost are hazards. Stripcropping, minimum tillage, leaving crop residues on the surface, and long rotations in permanent vegetation help reduce soil blowing. Building up the organic matter content by using green manure crops and long grass rotations can increase the moisture holding capacity and make the soil better withstand the droughty conditions. Growing short-season and hardy crops helps to offset the frost conditions. Water management is the main problem on pastures, but the use of shallow field ditches can lower the water table sufficiently.

The main management problem on woodland is seedling mortality. Trees adapted to a seasonally high water table and seasonally droughty conditions should be planted.

The seasonally high water table from November until June adversely affects sanitary facilities and community development. There is rare, very brief flooding. This soil should not be used as septic tank absorption fields. Protection from flooding is needed in areas of community development. Shrink-swell and frost action are two problems in using the soils for local roads and streets. The upper layer of the soil should be replaced or covered with a suitable base material so that local roads and streets will function properly. Capability subclass IIIw; Michigan soil management group (4/2b).

KaB—Kalkaska sand, 0 to 6 percent slopes. This nearly level to gently sloping, somewhat excessively drained soil is on upland plains. The soil is in 5- to 20-acre strips in valleys and in areas of 10 to 80 acres or more in other places throughout the county.

Typically, the surface layer is black sand about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

Included in mapping in some areas are somewhat poorly drained Au Gres soils in depressions. These soils make up about 15 percent of this map unit.

Permeability is rapid, and the available water capacity is low. Runoff is slow.

Most areas of this soil remain in woodland or are idle; a few areas are in crops or pasture or are used for houses. Some areas are used for specialty crops under very high levels of management, for example, potatoes under irrigation. This soil has poor potential for cultivated crops and fair potential for pasture and woodland. Its potential for recreation uses such as camp areas and picnic areas is fair, and for playgrounds and paths and trails the potential is poor. The potential for most engineering uses is good.

Soil blowing and drought are hazards for cultivated crops. Stripcropping, minimum tillage, leaving crop residues on the surface, and permanent vegetation help keep the surface soil from blowing. Droughtiness can be reduced by using green manure crops and grass for long periods in the rotation to increase the organic matter content. Restricting grazing during dry periods helps protect pasture from being overused and depleted.

The droughty condition is the main limitation to woodland use. The high seedling mortality is the main management problem. Replanting of seedlings may be necessary.

Excess seepage is a problem in sewage lagoons. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Because of the rapid permeability, water supplies can be polluted by sanitary facilities. Capability subclass IVs; Michigan soil management group (5a).

KcD—Kalkaska sand, 12 to 40 percent slopes. This strongly sloping to very steep, somewhat excessively drained soil is in deep depressions on upland plains. Individual areas range from 10 to 40 acres in size.

Typically, the Kalkaska soil has a black sand surface layer about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown, loose sand. The underlying material is light yellowish brown, loose sand.

Included in mapping are intermingled areas of somewhat excessively drained Karlin and East Lake soils and somewhat excessively drained or excessively drained Rubicon soils. These included soils make up about 15 percent of this map unit.

Permeability is rapid, and the available water capacity is low. Runoff is slow.

Most areas remain in woodland; a few areas are in pasture. This map unit has poor potential for cultivated crops and pasture and fair potential for woodland. The potential for recreation development and for most engineering uses is poor.

This map unit generally is not used for cultivated crops because of the steepness of the slope. Grazing should be restricted to help maintain the grasses.

Erosion hazard, equipment limitations, and seedling mortality are the management problems on woodland in the seasonally frosty or warm areas. Logging roads

should be located with care to reduce erosion. Heavy equipment should be operated with care on the steep slopes. Replanting of seedlings may be necessary.

The steepness of slope and seepage are the main limitations for sanitary facilities; this soil generally is not suited to this use. Steepness of slope is the main limitation for community development. Capability subclass VIIs; Michigan soil management group (5a).

KeB—Kalkaska-East Lake complex, 0 to 6 percent slopes. This map unit consists of nearly level and gently sloping, somewhat excessively drained soils on upland plains. Individual areas are generally 40 to 100 acres or more in size and are made up of about 50 percent Kalkaska soils and 30 percent East Lake soils. The East Lake soils are mainly on low ridges. The soils in this complex are so intricately mixed that they were not separated in mapping.

Typically, Kalkaska soils have a surface layer of black sand about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown, loose sand. The underlying material is light yellowish brown, loose sand.

Typically, East Lake soils have a surface layer of very dark gray gravelly loamy sand about 7 inches thick. The subsoil is about 19 inches thick. The upper part is yellowish red and dark reddish brown, very friable gravelly loamy sand. The lower part is yellowish brown, loose sand. The underlying material, to a depth of 60 inches, is multicolored stratified sand and gravel. The upper part of the subsoil is darker colored and not so thick in some areas.

Included with these soils in mapping and making up about 20 percent of the map unit are intermingled areas of well drained sandy soils that are loamy in the lower part of the subsoil and somewhat excessively drained Karlin soils. In most places these included soils have more dense vegetation than the Kalkaska and East Lake soils. Also included are some small, low areas where the water table is within 2 to 3 feet of the surface in winter and spring.

Permeability is rapid in these soils, and the available water capacity is very low or low. Runoff is slow.

Most areas are either idle or are cropland or woodland. A few areas are in pasture, and some are used for houses. This map unit has poor potential for cultivated crops and fair potential for pasture and woodland. The potential for development of camp areas and picnic areas is fair, and the potential for playgrounds and paths and trails is poor. The potential for most engineering uses is good.

Soil blowing and drought are hazards for cultivated crops and pasture. Stripcropping, minimum tillage, leaving crop residues on the surface, or permanent vegetation will help keep the surface soil from blowing (fig. 6). Droughtiness can be reduced by using green manure crops and grass for long periods in the rotation to increase the organic matter content. Restricting grazing during dry periods helps protect pasture from being overused and depleted.

Seedling mortality is the major management problem in woodlands. Replanting of seedlings may be necessary.

Sewage lagoons and sanitary landfills are affected by excess seepage. Sealing the lagoon with impervious material helps to correct the problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Because of the rapid permeability, water supplies can be polluted by sanitary facilities. Capability subclass IVs; Michigan soil management group (5a).

KeD—Kalkaska-East Lake complex, 6 to 40 percent slopes. This map unit consists of moderately sloping to steeply sloping, somewhat excessively drained soils on upland plains. Individual areas generally are about 10 to 80 acres or more in size and are made up of about 50 percent Kalkaska soils and 40 percent East Lake soils. These soils are so intricately mixed that they were not separated in mapping.

Typically, Kalkaska soils have a black sand surface layer about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

Typically, East Lake soils have a very dark gray gravelly loamy sand surface layer about 7 inches thick. The subsoil is about 19 inches thick. The upper part is yellowish red and dark reddish brown, very friable gravelly loamy sand. The lower part is yellowish brown loose sand. The underlying material, to a depth of 60 inches, is multicolored stratified sand and gravel. The upper part of the subsoil is darker colored and not so thick in some areas.

Included with these soils in mapping and making up about 10 percent of the map unit are areas of well drained sandy soils that are loamy in the lower part of the subsoil and somewhat excessively drained Karlin soils. In most places, these soils have more dense vegetation than the Kalkaska and East Lake soils.

Permeability is rapid, and the available water capacity is very low to low. Runoff is slow.

Most areas are idle or are woodland. A few areas are in crops or pasture. This map unit has poor potential for cultivated crops and fair potential for pasture and woodland. The potential for recreation uses such as camp areas, picnic areas, playgrounds, and paths and trails is poor. The potential for most engineering uses is fair to poor.

Soil blowing and drought are hazards to use for pasture. Permanent vegetation prevents the surface soil from blowing. Grass adds organic matter to the soil, which helps increase the available water capacity. Restricting grazing during dry periods can help protect pasture from being overused and depleted.

Seedling mortality, equipment limitations, and erosion hazard are the major management problems for use as

woodland. Replanting of seedlings may be necessary. Logging roads should be located with care to reduce erosion.

Slope is a problem in using the soils for sanitary facilities and community development. Land forming may be needed. Roads and streets should be built on the contour. Sewage lagoons are affected by excess seepage. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Because of the rapid permeability, water supplies can become polluted. Capability subclass VIs; Michigan soil management group (5a).

KkB—Kalkaska-Karlin complex, 0 to 6 percent slopes. This map unit consists of nearly level and gently sloping, somewhat excessively drained soils on upland plains. Individual areas are 100 to 500 acres or more in size and are made up of about 50 percent Kalkaska soils and 40 percent Karlin soils. These soils are so intricately mixed or so small in size that it is not practical to separate them in mapping.

Typically, Kalkaska soils have a surface layer of black sand about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand.

Typically, Karlin soils have a surface layer of gray loamy fine sand about 3 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown and dark brown, very friable loamy fine sand. The lower part is brown, loose loamy sand. The underlying material is light yellowish brown, loose sand.

Included with these soils in mapping and making up about 10 percent of the map unit are intermingled areas of somewhat excessively drained to excessively drained Rubicon soils. The vegetation is less dense on the Rubicon soils than on the other soils in this unit.

Permeability is rapid in the Kalkaska soils and moderately rapid in the Karlin soils. The available water capacity is low in the Kalkaska and Karlin soils. Runoff is slow.

Most areas of this map unit are woodland (fig. 7). A few areas are either in crops or pasture, are idle, or are used for houses. This unit has poor potential for cultivated crops, and fair potential for pasture and woodland. Its potential for recreation uses such as camp areas and picnic areas is fair, and the potential for playgrounds and for paths and trails is poor. The potential for most engineering uses is good.

The management problems for cultivated crops are soil blowing and droughty conditions. Stripcropping, minimum tillage, leaving crop residues on the surface, and long rotations in grass and permanent vegetation can be used to control soil blowing. Use of green manure crops, grass in long rotations, and permanent vegetation help increase the organic matter content. The available water capacity thus is increased, and droughtiness is lessened. The main problem in pasture management is the droughty condition. Grazing should be restricted during dry periods to protect the pasture from overuse.

The main management problem in woodland use is seedling mortality. Replanting of seedlings may be necessary.

Seepage is the main problem if the soils are used for sewage lagoons. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used or slopes should be properly graded. Because of the rapid permeability, water supplies can become polluted. Capability subclass IVs; Michigan soil management group (5a-4a).

KmB—Kalkaska-Montcalm complex, 0 to 12 percent slopes. This complex consists of nearly level to moderately sloping, somewhat excessively drained and well drained soils on uplands. Some areas of this complex have simple slopes, and some have complex slopes. This complex is commonly on hilltops, in valleys between hills, and on foot slopes of steep hills. The areas are 20 to 80 acres or more in size, and most are irregularly shaped. This complex is about 40 percent Kalkaska soils, 30 percent Montcalm soils, and 30 percent other soils. The Kalkaska and Montcalm soils are usually so intermingled that they were not separated in mapping.

Typically, the Kalkaska soils have a black sand surface layer about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

Typically, the Montcalm soils have a pinkish gray loamy sand surface layer 3 inches thick. The subsoil is about 46 inches thick. The upper part is reddish brown, very friable loamy sand. The middle part is multicolored, very friable loamy sand. The lower part consists of thin, interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

Included with these soils in mapping are intermingled areas of well drained and moderately well drained Emmet soils and somewhat excessively drained East Lake soils. The Emmet soils are finer textured, and the East Lake soils have a lower available water capacity. These included soils make up about 20 to 25 percent of this complex.

Permeability is rapid in Kalkaska and Montcalm soils. The available water capacity is low in the Kalkaska soils and moderate in the Montcalm soils. Runoff is slow.

Most areas of this map unit are in woodland, cropland, or pasture, but a few areas are idle or are used for houses. This unit has poor potential for cultivated crops and fair potential for pasture and woodland. Its potential is fair for recreation uses such as camp areas and picnic areas and poor for playgrounds and paths and trails. The potential for most engineering uses is good to fair.

Drought, soil blowing, and water erosion are hazards for cultivated crops. Blowing and erosion can be controlled by use of stripcropping, minimum tillage, crop residues on the surface, or permanent vegetation. Increasing the organic matter content by the use of green manure crops, barnyard manure, and long rotation in grass helps to increase the water supplying capacity and to lessen the droughty condition. Restricting grazing during dry periods helps protect pasture from being overused and depleted.

Seedling mortality and plant competition are the two main management problems on woodland. Replanting of seedlings may be necessary. Selective spraying and planting in furrows reduces plant competition.

Septic tank absorption fields should be located on slopes of less than 8 percent in this map unit. Sewage lagoons are adversely affected by seepage. The lagoon should be sealed with impervious material to help correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Because of the rapid permeability of these soils, septic tank absorption fields can pollute water supplies. Capability subclass IVs; Michigan soil management group (5a-4a).

KmD—Kalkaska-Montcalm complex, 12 to 40 percent slopes. This complex consists of strongly sloping and rolling to steep, somewhat excessively drained and well drained soils on uplands. The areas are about 40 to 100 acres or more in size and in most places are irregularly shaped. This complex is about 40 percent Kalkaska soils, 30 percent Montcalm soils, and 30 percent other soils. The Kalkaska and Montcalm soils are so intermingled that they were not separated in mapping.

Typically, the Kalkaska soils have a black sand surface layer about 1 inch thick. The subsurface layer is light brownish gray sand about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand. The lower part is yellowish brown loose sand. The underlying material is light yellowish brown loose sand.

Typically, the Montcalm soils have a pinkish gray loamy sand surface layer 3 inches thick. The subsoil is about 46 inches thick. The upper part is multicolored, very friable loamy sand; the lower part is thin interbedded layers of light yellowish brown, very friable loamy sand and reddish brown, firm sandy loam. The underlying material is brown, friable loamy sand.

Included with these soils in mapping are intermingled areas of well drained and moderately well drained Emmet soils and somewhat excessively drained East Lake soils. Emmet soils are finer textured, and East Lake soils have a lower available water capacity. These soils make up 20 to 25 percent of this complex.

Permeability is rapid. The available water capacity is low in the Kalkaska soils and moderate in the Montcalm soils. Runoff is slow on the Kalkaska soils and moderate on the Montcalm soils.

Most areas of this map unit are in woodland or pasture, but some areas are in crops, recreation use such as ski resorts, or are idle. This unit has poor potential for cultivated crops and fair potential for pasture and woodland. The potential for recreation development, including camp areas, picnic areas, paths and trails, and playgrounds, is poor. The potential for most engineering uses is also poor.

Permanent vegetation keeps the soil from blowing and helps prevent water erosion (fig. 8). Grass adds organic matter to the soil, which helps increase the available water capacity. Restricting grazing during dry periods helps protect pastures from being overused and depleted.

Erosion hazard, equipment limitation, seedling mortality, and plant competition are the main management problems on woodland. Logging roads should be located with care to reduce erosion. Heavy equipment should be operated with care. Replanting of seedlings may be necessary. Selective spraying and planting in furrows helps reduce plant competition.

Slope is the main problem for sanitary facilities and community development. Land forming is needed in many places. Roads and streets should be built on the contour. Seepage is a problem in sewage lagoons. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks from caving in, retaining walls should be used. Because of the rapid permeability, water supplies can be polluted by septic tank absorption fields. Capability subclass VIs; Michigan soil management group (5a-4a).

KsA—Kawkawlin silt loam, 0 to 3 percent slopes. This nearly level and gently sloping, somewhat poorly drained soil is in upland depressions that are rarely flooded. The areas are commonly 5 to 20 acres or more in size.

Typically, this soil has a grayish brown silt loam surface layer about 7 inches thick. The subsoil, about 13 inches thick, is dominantly brown, mottled, firm silty clay loam. The underlying material, to a depth of 60 inches, is pale brown, mottled, firm silty clay loam.

Included with this soil in mapping are intermingled areas of poorly drained to very poorly drained Ensley soils in slight depressions, and somewhat poorly drained Iosco soils at the same elevation as Kawkawlin soils. Iosco soils are sandy in the upper part. These soils make up 10 to 15 percent of this map unit.

Permeability is moderately slow in this soil, and the available water capacity is high. Runoff is slow. The seasonally high water table is within 1 to 2 feet of the surface late in fall and in winter and spring.

Most areas of this soil are in crops, pasture, or woodland. A few areas are idle. If adequately drained, this soil has good potential for cultivated crops. It has good potential for pasture and woodland. Its potential for recreation uses such as camp areas, picnic areas, playgrounds, and paths and trails is poor. The potential for most engineering uses is also poor.

The main management problem for cultivated crops is excess water in the soil. Adequate artificial drainage is needed for crop production. Shallow field ditches with adequate outlets help lower the water table. Frost is a

hazard on this soil; short-season crops should be used. Shallow field ditches help to drain excess water on the soil to allow pasture use.

The main management problem on woodland is plant competition. Planting sites should be intensively prepared and maintained.

The seasonally high water table adversely affects sanitary facilities, including septic tank absorption fields, and community development. There is frost action on local roads and streets. Replacing or covering the upper layer of the soil with a suitable base material is necessary so that local roads and streets will function properly. Use of surface ditches or tile, or both, lowers the water table for community development. Capability subclass IIw; Michigan soil management group (1.5b).

Ps—Pickford silty clay loam. This nearly level, poorly drained soil is in oblong depressions and along waterways. This soil is subject to frequent flooding. The areas are commonly 10 to 40 acres or more in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, mottled, firm silty clay loam; the middle part is olive gray, mottled, firm silty clay; the lower part is greenish gray and yellowish brown, mottled, very firm clay. The upper part of the underlying material is multicolored clay and clay loam; the lower part is light yellowish brown, mottled sand.

Included with this soil in mapping are intermingled areas of somewhat poorly drained Kawkawlin and Iosco soils at slightly higher elevations. Iosco soils are sandy in the upper part. These included soils make up about 10 to 15 percent of this map unit.

Permeability of this soil is very slow. The available water capacity is moderate. Runoff is very slow to ponded. The seasonally high water table is at the surface or within 1 foot of the surface late in fall and in winter and spring.

Most areas of this soil are in woodland or pasture. A few areas are artificially drained and are in crops. This soil has good potential for woodland. It has poor potential for camp areas, picnic areas, playgrounds, and paths and trails. It has poor potential also for engineering uses.

The main management problem for cultivated crops is excess soil wetness and frost. Shallow field ditches can be used to remove surface water. Short season crops can be grown in frosty areas. If this soil is worked when it is too wet, compaction will develop and decreased yields will result. In pastures, excess wetness can be relieved by using shallow field ditches to remove surface water.

The main management problem for trees is a high water table. Trees normally are not planted in undrained areas of this soil. Eastern white pine and white spruce can be planted if the areas are adequately drained.

This soil is wet, has slow percolation, and is subject to flooding. Wetness and flooding adversely affect sanitary facilities and community development. Replacing or covering the upper layer of soil material with a suitable base material is necessary so local roads or streets will function properly. Capability subclass IIIw; Michigan soil management group (1c).

Pt—Pits. This miscellaneous area consists of open excavations from which soil and underlying material have been removed. These areas are 10 to 80 acres or more in size. Some of the pits contain water and have some potential for recreation use. Shale, sand, gravel, and loamy to clayey material have been removed from various areas. (Not placed in a capability subclass or Michigan soil management group.)

Ro—Roscommon mucky sand. This nearly level, poorly drained and very poorly drained soil is on lowlands. It is in depressions and adjacent to bogs and waterways. This soil is subject to frequent flooding. The areas are commonly 10 to 40 acres or more in size.

Typically, the surface layer is black mucky sand about 5 inches thick. The underlying material, to a depth of 60 inches, is multicolored loose sand.

Included with this soil in mapping are intermingled areas of somewhat poorly drained Au Gres soils and moderately well drained Croswell soils on low ridges and very poorly drained Tawas muck in depressions. These soils make up 10 to 15 percent of this map unit.

Permeability is rapid on this soil, and the available water capacity is low. Runoff is very slow or ponded. The water table is at the surface or within 1 foot of the surface from fall through spring.

Most areas of this soil are in woodland or are idle. A few areas are in pasture. This soil has poor potential for cultivated crops and woodland and fair potential for pasture. Its potential for camp areas, picnic areas, playgrounds, and paths and trails is poor. The potential for most engineering uses is poor.

The main management problem for pasture is soil wetness. The high water table can be lowered by use of field ditches. The low available water capacity can cause droughty conditions in overdrained areas in summer.

The main management problem for woodland is soil wetness and frequent flooding from September to May. Harvesting should be done during the driest time of year or when the ground is frozen.

Sanitary facilities and community development are adversely affected by wetness and flooding on this soil. Surface ditches and tile can be used to lower the water table. Rapid permeability causes a seepage problem in sewage lagoons. The lagoons should be sealed with impervious material. To prevent cutbanks in shallow excavations from caving in, excess water should be removed and retaining walls should be used. Capability subclass VIw; Michigan soil management group (5c).

RuB—Rubicon sand, 0 to 6 percent slopes. This nearly level and gently sloping, somewhat excessively drained to excessively drained soil is on upland plains. The areas are commonly 80 acres or more in size.

Typically, this soil has a black sand surface layer about 1 inch thick and a pinkish gray sand subsurface layer about 6 inches thick. The subsoil is dark brown and brownish yellow sand 20 inches thick. The underlying material is light yellowish brown sand.

Included with this soil in mapping are intermingled areas of the finer textured somewhat excessively drained Karlin soils. They make up about 10 percent of this map unit.

Permeability is rapid or very rapid in this soil, and the available water capacity is low. Runoff is slow.

Most areas of this soil are in woodland (fig. 9) or are idle, but a few areas are used for houses. This soil has good potential for woodland and poor potential for cultivated crops or pasture. Its potential for camp areas and picnic areas is fair, and for playgrounds and paths and trails the potential is poor. The potential for most engineering uses is good.

The low available water capacity is the main limitation if this soil is used for pasture. Restricting grazing during dry periods keeps pasture from being overused and depleted.

Droughtiness is the main hazard in woodland use. The high rate of seedling mortality is the main management problem on woodland. Replanting of seedlings may be necessary.

Sewage lagoons are affected by rapid seepage. Sealing the lagoon with impervious material helps to correct this problem. To prevent cutbanks in shallow excavations from caving in, retaining walls should be used. Because of rapid permeability, sanitary facilities on this soil can cause pollution of water supplies. Capability subclass VIs; Michigan soil management group (5.3a).

Ta—Tawas muck. This nearly level, very poorly drained organic soil is in bogs on uplands and on lowlands. This soil is subject to frequent flooding. The areas range from 10 to 1,000 acres in size. Some areas are small enclosed depressions.

Typically, the Tawas soil has a surface layer of black muck about 16 inches thick. The subsoil is dark reddish brown muck about 15 inches thick. The underlying material is grayish brown sand.

Included with this soil in mapping are intermingled areas of poorly drained and very poorly drained, sandy Roscommon soils and somewhat poorly drained Au Gres and Finch soils. Some areas have organic material more than 51 inches thick. Some areas are acid. These soils are only in some of the mapped areas and make up 10 to 15 percent of this map unit. Also included are some muck soils, in the Jordan River area, that are underlain by marl at variable depths.

Permeability is moderately slow to moderately rapid in the muck layers and rapid in the underlying sand. The available water capacity is very high in the muck and low in the sand part. Runoff is very slow or ponded. The shrink-swell potential and potential frost action are high. The water table is at the surface or within 1 foot of the surface from late in fall through spring.

Most areas of this map unit are in woodland or are idle (fig. 10). A few areas are in pasture. This map unit has poor potential for cultivated crops, fair potential for pasture, and poor potential for woodland. Its potential for recreation development is poor. The potential for engineering uses also is poor.

Excess water and frost action are the two major management problems to pasture use. Artificial drainage helps to remove excess water, but in many places outlets are difficult to make. Frost protection is impractical on this soil.

The major management problems on woodland are equipment limitation in tending and harvesting, high seedling mortality, high windthrow hazard, and severe plant competition. Heavy equipment should be used when the ground is frozen. Trees generally are not planted on this soil. Clear cutting reduces the windthrow hazard. Selective spraying reduces plant competition.

Soil wetness, flooding, and excess humus adversely affect sanitary facilities and community development. The organic material should be displaced or removed and replaced with suitable base material in constructing local roads and streets. Capability subclass VIw; Michigan soil management group (M/4c).

Te—Tawas-Ensley complex. This map unit consists of nearly level, poorly drained and very poorly drained soils in swamps and waterways. These soils are subject to frequent flooding. Individual areas of this complex range from 80 to 200 acres or more in size. The soils are so intricately mixed that they were not separated in mapping.

Typically, the Tawas soils have a black muck surface layer about 16 inches thick. The subsoil is dark reddish brown muck about 15 inches thick. The underlying material is grayish brown sand.

Typically, the Ensley soils have a very dark gray mucky sandy loam surface layer about 8 inches thick. The subsoil is about 28 inches thick. The upper part is light brownish gray, mottled, very friable loamy sand. The middle part is brown, mottled, very friable sandy loam. The lower part is light reddish brown, mottled, firm loam. The underlying material, to a depth of 60 inches, is light brownish gray sandy loam and pale brown gravelly loamy sand.

Included with this unit in mapping are poorly and very poorly drained Roscommon soils.

Permeability is moderately slow to moderately rapid in the muck layers and rapid in the underlying sand in the Tawas soils and moderate in the Ensley soils. The available water capacity is high in the Tawas soils and moderate in the Ensley soils. Runoff is slow to ponded. The water table is at the surface or within 1/2 to 1 foot of the surface from late in fall through spring.

Most areas are woodland or are idle. A few areas are in pasture. This unit has poor potential for cultivated crops, fair potential for pasture, and poor potential for woodland. The potential for camp areas, picnic areas, playgrounds, and paths and trails is poor. The potential for engineering uses also is poor.

Management problems in pasture use are wetness and flooding. Water-tolerant grasses should be used.

The management problems in woodland use are equipment limitations, seedling mortality, windthrow hazard, and plant competition. Trees generally are not planted on these soils. Heavy equipment should be used when the

ground is frozen. Clear cutting helps to reduce the windthrow hazard. Selective spraying helps to reduce plant competition.

Sanitary facilities and community development are adversely affected by the high water table, frequent long flooding, excess humus, and frost action. These soils generally are not suited to dwellings and sanitary facilities. If used for local roads and streets, the organic material should be displaced or removed and replaced with suitable material. The areas used for roads and streets should be drained by ditches or tile or both. Capability subclass VIw; Michigan soil management group (M/4c-3c).

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained (*5*); and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 99,000 acres in the survey area were used for crops and pasture in 1967 according to the Conservation Needs Inventory (*7*). Of this total, 23,800 acres were used for permanent pasture; 15,935 acres for row crops, mainly corn; 18,210 acres for close grown crops, mainly wheat and oats; 3,312 acres for rotation hay and pasture; 2,898 acres for hayland; 4,090 acres for conservation use; and 6,415 acres for orchards, vineyards, and bush fruit. The rest was idle cropland.

The potential of the soils in Antrim County for increased production of food is good. About 3,725 acres of potentially good cropland is currently used as woodland and about 8,485 acres as pasture. In addition to the reserve productive capacity of this land, food production could be increased considerably by extending the latest crop production technology to all cropland in the county.

Acreage in crops and pasture has gradually been decreasing as more and more land is used for urban development. In 1967 an estimated 19,473 acres in the county were urban and built-up land. The acreage has been growing at the rate of about 1,000 acres per year. The use of this soil survey in making land use decisions that can influence the future role of farming in the county is discussed in the section "General soil map for broad land use planning."

Soil erosion is the major soil problem on about half of the cropland and pasture in Antrim County. Where the slope is more than 3 percent, erosion is a hazard. Chestonia soils, for example, have slopes of 3 to 40 percent; they have an additional problem of wetness.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a loamy subsoil, for example, the Emmet and Onaway soils. Erosion also reduces productivity on soils that tend to be droughty, for example, Montcalm soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal and recreation use and for fish and wildlife.

In many sloping fields the original friable surface layer has eroded away, and preparing a good seedbed and tillage on the exposed clayey spots is difficult. Clayey spots are common in areas of Emmet and Onaway soils.

Erosion control practices provide a protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps a plant cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, where pasture and hay are required, the legume and grass forage crops in the cropping system reduce erosion on sloping land and provide nitrogen and improve tilth for the following crop.

In some areas of the sloping Emmet, Montcalm, and Onaway soils, slopes are so short and irregular that contour tillage is not practical. On these soils, a cropping system that provides substantial vegetative cover is required to control erosion unless minimum tillage is practiced. Minimum tillage and leaving crop residue on the surface help to increase infiltration and to reduce the hazard of erosion. These practices can be adapted to most soils in the survey area, but they are more difficult to use successfully on the eroded soils and on the soils that have a silty surface layer, such as Chestonia and Pickford soils. Zero tillage for corn, which is common on an increasing acreage, is effective in reducing erosion on sloping land and can be adapted to most soils in the survey area. Zero tillage, however, is less successful on soils that have a silty surface layer.

Contouring and contour stripcropping are widespread erosion control practices in the survey area. They are best adapted to soils that have smooth, uniform slopes, including many areas of the sloping Emmet, Onaway, and Montcalm soils.

Soil blowing is a hazard on the sandy Croswell, East Lake, Iosco, Kalkaska, and Montcalm soils. Soil blowing can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage and wind stripcropping minimize soil blowing on these soils.

Soil drainage is the major management need on about one-tenth of the acreage in the survey area that is used for crops and pasture. The poorly drained and very poorly drained Ensley, Pickford, and Roscommon soils and the organic Tawas soils are naturally so wet that the production of crops common to the area generally is not possible on these soils.

Unless artificially drained, the Au Gres, Charlevoix, Chestonia, Finch, Iosco, and Kawkawlin soils are so wet that crops on these soils are damaged in most years.

Onaway soils have good natural drainage most of the year, but they tend to dry out slowly in the spring and after rains. Small areas of wetter soils along drainageways and in swales are commonly included in areas of the moderately well drained parts of the Emmet and Onaway soils, especially those that have slopes of 3 to 12 percent. Artificial drainage is needed in some of these wetter areas.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and tile drainage is needed in most areas of poorly drained and very poorly drained soils that are used intensively for row crops. Drains should be more closely spaced in soils that have slow permeability than in the more permeable soils. Tile drainage is very slow in Pickford soils. Finding adequate outlets for tile drainage systems is difficult in many areas.

Organic soils oxidize and subside when their pore space is filled with air; therefore, special drainage systems are needed to control the depth and the period of drainage. Keeping the water table at the level required by crops during the growing season and raising it to the surface during other parts of the year minimize the oxidation and subsidence of organic soils.

Soil fertility is naturally medium to low in most soils of the uplands in the survey area. Most of the soils are naturally acid. The soils on lowlands, such as Ensley and Pickford soils, range from slightly acid to mildly alkaline and are naturally higher in plant nutrients than most upland soils. Charlevoix and Kawkawlin soils, in low swales and drainageways, are slightly acid or neutral.

Many upland soils are naturally very strongly acid, and if they have never been limed, they require applications of ground limestone to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on nearly neutral soils. Available phosphorus and potash levels are naturally low in most of these soils. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply (*2*).

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the soils used for crops in the survey area have a surface layer of sandy loam or loamy sand that is light in color and low in content of organic matter. Generally the structure of such soils is weak, and intense rainfall causes the surface to crust. The crust is hard when it is dry, and it is slowly pervious to water. The crust reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material can help to improve soil structure and to reduce crust formation.

Fall plowing is generally not a good practice on the light colored soils that have a sandy loam surface layer because of the crust that forms in winter and spring. Many of the soils are nearly as dense and hard at planting time after fall plowing as they were before they were plowed. Also, about one-half of the cropland is on sloping soils that are subject to damaging erosion if they are plowed in the fall.

The darker colored Chestonia, Kawkawlin, and Pickford soils are silty, and tilth is a problem because the soils often stay wet until late in spring. If these soils are wet when plowed, they tend to be very cloddy when dry, and good seedbeds are difficult to prepare. Fall plowing generally results in good tilth in spring.

Field crops suited to the soils and climate of the survey area include many crops that are not now commonly grown. Corn and, to an increasing extent, potatoes are the row crops that are grown. Sunflowers and navy beans and similar crops can be grown if economic conditions are favorable.

Wheat and oats are the common close-growing crops. Rye, barley, and buckwheat could be grown, and grass seed could be produced from bromegrass, fescue, redtop, and bluegrass.

Special crops grown commercially in the survey area are vegetables, small fruits, tree fruits, and nursery plants. A small acreage on the west side of the county is used for strawberries, raspberries, asparagus, sweet corn, and other vegetables and small fruits. In addition, large areas can be adapted to other special crops such as grapes and many vegetables. Apples and cherries are the most important tree fruits grown in the county.

Most of the well drained loamy soils on the west side of the county are suitable for orchards and nursery plants. Soils in low positions, however, where frost is common and air drainage is poor, generally are poorly suited to small fruits and orchards.

Latest information and suggestions for growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop or the crop is not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is indicated in table 6. All soils in the survey area except those named at a level higher than the series are included. Some of the soils that are well suited to crops and pasture may be in low-intensity use, for example, soils in capability classes I and II. Data in this table can be used to determine the farming potential of such soils.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning." Listed at the end of the description of each map unit are the capability subclass and Michigan soil management group (shown in parentheses). For the soil complexes the soil management groups are listed in the same order as the named series. These management groups are used for making recommendations about applications of lime and fertilizer, about artificial drainage, and about other practices. For explanation of these groups, refer to Michigan State University Research Report 254, "Soil management units and land use planning" (*3*).

Woodland management and productivity

Table 7 contains information useful to woodland owners or forest managers planning use of the soils for wood crops. Only those soils suitable for wood crops are listed.

In table 7 the soils are also rated for a number of factors to be considered in management. *Slight*, *moderate*, and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable trees on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 8 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 8 based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 9 shows, for each kind of soil, the degree and kind of limitations for building site development; table 10, for sanitary facilities. Table 12 shows the kind of limitations for water management. Table 11 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 9. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 9 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Slope and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 9 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 10 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, and *poor*, which mean about the same as *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, and susceptibility to flooding. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. Where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 10 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 11 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 15 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low frost action potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 11 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 15.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel or stones.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel or stones; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 12 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of the soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 12 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 13 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 13 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 10, and interpretations for dwellings without

basements and for local roads and streets, given in table 9.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 14, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, timothy, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are strawberries, goldenrod, dandelions, wild oats, and nightshade.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of hardwood plants are oak, maple, beech, thornapple, hawthorn, dogwood, blackberry, and blueberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cattails, and arrowhead and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include woodchuck, hawk, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include warbler, ruffed grouse, woodcock, owl, woodpeckers, squirrels, gray fox, raccoon, deer, and snowshoe hare.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in-place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 15 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 15 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 15 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (*8*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six

classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 15. Also in table 15 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and in plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 16 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific

kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 17 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Cemented pans are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Au Gres series

The Au Gres series consists of somewhat poorly drained, rapidly permeable soils on outwash plains, sandy lake plains, and till plains. The soils formed in sandy glacial drift. Slope ranges from 0 to 4 percent.

Au Gres soils are similar to Croswell and Finch soils and are commonly adjacent to Roscommon and Kalkaska soils. Croswell and Kalkaska soils do not have mottles in the B2ir horizon. Finch soils are cemented in more than 50 percent of the B horizon. Roscommon soils are grayer than Au Gres soils and they do not have a spodic horizon.

Typical pedon of Au Gres sand, in an area of Au Gres-Finch sands, 0 to 4 percent slopes, 2,145 feet east and 510 feet north of SW corner of sec. 32, T. 31 N., R. 6 W.

A1—0 to 1 inch; black (10YR 2/1) and pinkish gray (7.5YR 6/2) sand and organic duff; weak fine granular structure; very friable; very strongly acid; abrupt smooth boundary.

A2—1 to 6 inches; pinkish gray (7.5YR 6/2) sand; single grained; loose; many fine roots; medium acid; abrupt irregular boundary.

B21hir—6 to 8 inches; dark reddish brown (5YR 3/3) sand; few fine distinct strong brown (7.5YR 5/6) mottles; very weak medium subangular blocky structure; very friable; many fine roots; very strongly acid; abrupt broken boundary.

B22ir—8 to 18 inches; reddish brown (5YR 5/4) sand; common medium distinct strong brown (7.5YR 5/6) mottles; single grained; loose; common fine roots; strongly acid; clear wavy boundary.

B3—18 to 24 inches; strong brown (7.5YR 5/6) sand; common coarse distinct olive brown (2.5Y 4/4) and common fine distinct light yellowish brown (10YR 6/4) mottles; single grained; loose; common fine roots; medium acid; clear wavy boundary.

C1—24 to 32 inches; light yellowish brown (10YR 6/4) sand; common medium faint yellowish brown (10YR 5/4) mottles; single grained; loose; few fine roots; slightly acid; clear wavy boundary.

C2—32 to 60 inches; pale brown (10YR 6/3) sand; common medium faint yellowish brown (10YR 5/4) mottles; single grained; loose; thin strata of coarse fragments at a depth of 48 inches; slightly acid.

The thickness of the solum ranges from 20 to 48 inches. The solum ranges from very strongly acid to neutral. Cultivated areas have an Ap horizon with hue of 10YR, value of 3 or 4, and chroma of 1. The B22ir horizon contains cemented chunks of sand in some pedons.

Charlevoix series

The Charlevoix series consists of somewhat poorly drained, moderately permeable or moderately rapidly permeable soils that formed in loamy calcareous glacial till. Slopes range from 0 to 4 percent.

Charlevoix soils are commonly adjacent to Emmet and Ensley soils. Emmet soils are better drained than Charlevoix soils. Ensley soils do not have a spodic and argillic horizon.

Typical pedon of Charlevoix sandy loam, 0 to 4 percent slopes, 2,640 feet north and 660 feet west of SE corner of sec. 14, T. 32 N., R. 9 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam; weak coarse granular structure; friable; common medium and fine roots; slightly acid; abrupt smooth boundary.

A2—9 to 11 inches; light brownish gray (10YR 6/2) loamy sand; few faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; very friable; common medium and fine roots; neutral; abrupt broken boundary.

Bhir—11 to 14 inches; dark reddish brown (5YR 3/3) sandy loam; common fine faint dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; common fine roots; slightly acid; abrupt wavy boundary.

B&A—14 to 20 inches; brown (7.5YR 5/4) sandy loam (B2t) and light brown (7.5YR 6/4) sandy loam (A2); common fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few large roots; neutral; clear wavy boundary.

B3—20 to 33 inches; brown (7.5YR 5/4) sandy loam; common fine faint strong brown (7.5YR 5/6) mottles; weak very thick platy structure parting to weak medium subangular blocky; friable; patchy clay films on faces of peds; stone line in upper part of horizon; few large roots; slight effervescence; moderately alkaline; gradual wavy boundary.

C1—33 to 44 inches; pale brown (10YR 6/3) gravelly sandy loam; common fine faint yellowish brown (10YR 5/6) mottles; massive; friable; 20 percent gravel; strongly effervescent; lime segregated in fine irregular soft masses; moderately alkaline; gradual wavy boundary.

C2—44 to 60 inches; pale brown (10YR 6/3) sandy loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; very friable; strong effervescence; moderately alkaline.

The solum is 16 to 40 inches thick. It is slightly acid or neutral. There is no A2 horizon in some cultivated areas. The Bhir horizon is 3 to 9 inches thick and has color hue of 10YR to 5YR, value of 3 to 5, and chroma of 3 or 4. Some pedons have separate A'2 and B'2t horizons. The texture of the C horizon is sandy loam, gravelly sandy loam, or loamy sand. Effervescence ranges from slight to violent.

Chestonia series

The Chestonia series consists of somewhat poorly drained, very slowly permeable soils on glacial till uplands. The soils formed in material that weathered from shale. Slope ranges from 3 to 40 percent.

Chestonia soils are similar to Pickford soils and are commonly adjacent on the landscape to Emmet, Kalkaska, and Montcalm soils. Pickford soils do not have shale fragments throughout the pedon. Emmet, Kalkaska, and Montcalm soils have less clay throughout and are better drained than Chestonia soils.

Typical pedon of Chestonia silty clay loam, 12 to 40 percent slopes, 680 feet west and 400 feet south of the NE corner of sec. 11, T. 31 N., R. 7 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) silty clay loam; strong fine subangular blocky structure; firm; neutral; abrupt wavy boundary.

B1g—4 to 9 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common medium distinct light yellowish brown (10YR 6/4) mottles; moderate medium angular blocky structure; very firm; 10 percent shale fragments; neutral; gradual wavy boundary.

B2g—9 to 16 inches; mottled dark grayish brown (2.5Y 4/2) and light yellowish brown (10YR 6/4) clay loam; massive; firm; 10 percent shale fragments; neutral; gradual wavy boundary.

Cg—16 to 60 inches; gray (5Y 5/1) shaly silty clay; common prominent coarse light yellowish brown (2.5Y 6/4) mottles; massive; very firm; 25 percent shale fragments; mildly alkaline.

The solum is 12 to 24 inches thick. It is slightly acid or neutral. The C horizon is mildly alkaline or moderately alkaline, and it is slightly effervescent in some pedons. The shale fragments in the solum are strongly weathered and range from 5 to 15 percent by volume. In the C horizon they range from 10 to 35 percent by volume.

The A1 horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes clay loam.

The B1g horizon has hue of 2.5Y, 5Y, or 10YR, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. The B2 horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 4. It has many mottles with chroma of 4 or more. It is silty clay loam, clay loam, or silty clay.

The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 4. It is clay loam, silty clay loam, silty clay, or the shaly analogs of these textures.

Croswell series

The Croswell series consists of moderately well drained, rapidly permeable soils on outwash plains, sandy lake plains, dunes, till plains, and moraines. The soils formed in glacial drift of Wisconsin age. Slopes range from 0 to 4 percent.

Croswell soils are similar to Deer Park, Kalkaska, and Rubicon soils and are commonly adjacent to Au Gres and Finch soils. Deep Park soils do not have a spodic horizon. Kalkaska and Rubicon soils are better drained. Au Gres and Finch soils are more poorly drained. In addition, the Finch soils have a cemented B horizon.

Typical pedon of Croswell sand, 0 to 4 percent slopes, 231 feet west and 1,320 feet south of NE corner of sec. 32, T. 31 N., R. 6 W.

A1—0 to 1 inch; black (10YR 2/1) sand; single grained; loose; many fine roots; strongly acid; abrupt smooth boundary.

A2—1 to 6 inches; pinkish gray (7.5YR 6/2) sand; single grained; loose; common fine roots; very strongly acid; abrupt irregular boundary.

B21hir—6 to 7 inches; dark reddish brown (5YR 3/2) sand; very weak medium granular structure; very friable; common fine roots; very weak cementation in part of pedon; very strongly acid; abrupt irregular boundary.

B22ir—7 to 11 inches; reddish brown (5YR 4/4) sand; very weak medium granular structure; very friable; common fine roots; ortstein chunks in part of pedon; strongly acid; clear wavy boundary.

B3—11 to 30 inches; strong brown (7.5YR 5/8) sand; common fine distinct pale brown (10YR 6/3) mottles; single grained; loose; common fine roots in upper part and few fine roots in lower part; medium acid; clear wavy boundary.

C1—30 to 38 inches; pale brown (10YR 6/3) sand; many fine and medium distinct yellowish brown (10YR 5/6) and many fine distinct brownish yellow (10YR 6/6) mottles; single grained; loose; few fine roots; medium acid; clear wavy boundary.

C2—38 to 60 inches; very pale brown (10YR 7/3) sand; many coarse faint light yellowish brown (10YR 6/4) and many medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few thin strata of coarse fragments; slightly acid.

The solum is 24 to 40 inches thick. It ranges from very strongly acid to slightly acid. This soil, if cultivated, has an Ap horizon that has hue of 10YR, value of 2 to 4, and chroma of 2. Mottles are faint in the solum in some pedons. The C horizon ranges from medium acid to neutral.

Deer Park series

The Deer Park series consists of excessively drained, rapidly permeable soils on stabilized sand dunes. The soils developed in acid sand. Slopes range from 2 to 20 percent.

Deer Park soils are similar to Croswell and Rubicon soils and are commonly adjacent to Roscommon soils. Croswell soils are mottled and have a spodic horizon. Rubicon soils also have a spodic horizon. Roscommon soils have a darker colored A horizon and are mottled in the C horizon.

Typical pedon of Deer Park sand, 2 to 20 percent slopes, 1,300 feet west and 90 feet north of SE corner, sec. 22, T. 30 N., R. 9 W.

O1—1 inch to 0; very dark grayish brown (10YR 3/2) well decomposed leaf litter; abrupt smooth boundary.
A2—0 to 9 inches; light gray (10YR 7/2) sand; single grained; loose; many fine and medium roots; medium acid; abrupt irregular boundary.
B1—9 to 19 inches; brownish yellow (10YR 6/6) sand; single grained; loose; many fine and medium roots; strongly acid; clear wavy boundary.
B2—19 to 39 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few medium and fine roots; dark brown (7.5YR 4/4) root channels; medium acid; clear wavy boundary.
B3—39 to 54 inches; mixed very pale brown (10YR 7/3) and yellow (10YR 7/6) sand; single grained; loose; few fine roots; slightly acid; gradual wavy boundary.
C—54 to 60 inches; mixed light yellowish brown (10YR 6/4) and light brownish gray (10YR 6/2) sand; single grained; loose; slightly acid; gradual wavy boundary.

The solum ranges from 18 to 54 inches in thickness. It is slightly acid to strongly acid. It is fine sand in some pedons. Some pedons have an A1 horizon that ranges from 1 to 5 inches in thickness. That horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2.

East Lake series

The East Lake series consists of somewhat excessively drained, rapidly permeable soils on outwash plains, sandy lake plains, and beach ridges. These soils formed in sandy glacial drift. Slope ranges from 0 to 40 percent. These soils have a thinner and lighter colored B2ir horizon than that in the defined range for the series. This difference does not alter the use or behavior of the soils.

East Lake soils are similar to Kalkaska and Rubicon soils. Kalkaska and Rubicon soils do not have a calcareous sand and gravel C horizon.

Typical pedon of East Lake gravelly loamy sand, 0 to 6 percent slopes, 700 feet east and 100 feet south of NW corner of sec. 16, T. 29 N., R. 6 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) gravelly loamy sand; weak medium granular structure; very friable; many fine roots; 20 percent pebbles; neutral; abrupt smooth boundary.
B21ir—7 to 13 inches; yellowish red (5YR 4/6) gravelly loamy sand; weak fine subangular blocky structure; very friable; many fine roots; 20 percent pebbles; slightly acid; clear irregular boundary.
B22ir—13 to 18 inches; dark reddish brown (5YR 3/3) gravelly loamy coarse sand; weak coarse granular structure; very friable; few fine roots; 20 percent pebbles; mildly alkaline; clear irregular boundary.
B3—18 to 26 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few fine roots; mildly alkaline; abrupt wavy boundary.
C1—26 to 28 inches; dark reddish brown (5YR 3/3) gravelly sand; single grained; loose; common fine roots; 20 percent pebbles; slight effervescence; moderately alkaline; abrupt wavy boundary.
IIC2—28 to 34 inches; light yellowish brown (10YR 6/4) and yellowish brown (10YR 5/6) sand and gravel; single grained; loose; few fine roots; strong effervescence; moderately alkaline.
IIC3—34 to 60 inches; pale brown (10YR 6/3) sand and gravel; single grained; loose; strong effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. It ranges from medium acid to mildly alkaline. Undisturbed areas have an A1 and an A2 horizon. The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 and is 2 to 4 inches thick. The A2 horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The A horizon is dominantly gravelly loamy sand, but in places it is sand and loamy sand. The B horizon is sand or loamy sand or the gravelly analogs of these textures. Hue of the B horizon ranges from 10YR to 5YR.

Emmet series

The Emmet series consists of well drained and moderately well drained, moderately permeable soils on glacial till uplands. The soils formed in calcareous glacial till. Slopes range from 3 to 40 percent.

Emmet soils are similar to Montcalm and Onaway soils and are commonly adjacent to Charlevoix soils. Montcalm soils are less clayey throughout. Onaway soils have a finer textured B2t horizon. Charlevoix soils have mottles in the upper part of the solum.

Typical pedon of Emmet sandy loam, in an area of the Emmet-Montcalm complex, 3 to 12 percent slopes, 2,140 feet north and 150 feet east of SW corner, sec. 36, T. 29 N., R. 9 W.

A1—0 to 4 inches; black (10YR 2/1) sandy loam; weak medium granular structure; friable; many fine roots; neutral; abrupt smooth boundary.
A2—4 to 7 inches; light brownish gray (10YR 6/2) loamy sand; weak very fine subangular blocky structure; very friable; many fine roots; neutral; abrupt irregular boundary.
B2ir—7 to 16 inches; reddish brown (5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; slightly acid; clear broken boundary.
A&B—16 to 27 inches; pinkish gray (7.5YR 6/2) loamy sand (A2); weak fine subangular blocky structure; very friable; slightly acid; intermingled with reddish brown (5YR 4/4) sandy loam (Bt); weak coarse subangular blocky structure; friable; few fine roots; medium acid; clear wavy boundary.
B2t—27 to 41 inches; reddish brown (5YR 4/4) sandy clay loam; weak coarse subangular blocky structure; friable; few fine roots; clay films on ped surfaces; moderately alkaline; clear wavy boundary.
C—41 to 60 inches; light brown (7.5YR 6/4) sandy loam; very weak medium angular blocky structure or massive parting to very weak thick platy; friable; 5 to 10 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 48 inches. The A2 horizon is loamy sand or sandy loam. There is an Ap horizon where the soil has been cultivated. That horizon has hue of 10YR, value of 3 or 4, and chroma of 2. The B2ir horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5, and chroma of 3 or 4. The A part of the A&B horizon is a separate horizon in some pedons. The B2t horizon is light sandy clay loam, loam, or sandy loam. The C horizon contains lenses of loam, loamy sand, sand, or gravel in some pedons.

Ensley series

The Ensley series consists of poorly drained or very poorly drained, moderately permeable soils in depressions on glacial till uplands. The soils formed in loamy calcareous glacial till. Slope ranges from 0 to 2 percent.

Ensley soils are adjacent to Tawas soils. Tawas soils have organic material 16 to 51 inches thick underlain by sandy material.

Typical pedon of Ensley mucky sandy loam, in an area of Tawas-Ensley complex, 850 feet south and 2,690 feet west of NE corner of sec. 31, T. 32 N., R. 9 W.

A1—0 to 8 inches; very dark gray (10YR 3/1) mucky sandy loam; moderate medium granular structure; very friable; neutral; abrupt smooth boundary.

B1g—8 to 13 inches; light brownish gray (10YR 6/2) loamy sand; common fine faint brownish yellow (10YR 6/6) and many medium distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very friable; mildly alkaline; gradual wavy boundary.

B21—13 to 27 inches; brown (7.5YR 5/4) sandy loam; few fine distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; very friable; mildly alkaline; clear wavy boundary.

B22—27 to 36 inches; light reddish brown (5YR 6/3) loam; many coarse distinct brownish yellow (10YR 6/6) and common medium distinct light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; slight effervescence; moderately alkaline; clear wavy boundary.

C1g—36 to 49 inches; light brownish gray (10YR 6/2) sandy loam; massive; very friable; strong effervescence; moderately alkaline; clear wavy boundary.

C2—49 to 60 inches; pale brown (10YR 6/3) gravelly loamy sand; massive; very friable; strong effervescence; moderately alkaline.

The solum ranges from 15 inches to 40 inches in thickness. The upper part of the solum is slightly acid to mildly alkaline, and the lower part is mildly alkaline or moderately alkaline.

If the soil has been plowed, the Ap horizon has value of 2 or 3 and chroma of 1 or 2. Texture of the A horizon is dominantly mucky sandy loam but includes sandy loam or loamy sand. The B1g horizon has hue of 10YR or 2.5Y and value of 4 to 7. Its texture is loamy sand or sandy loam. The B21 horizon has hue of 7.5YR or 10YR. The B22 horizon has hue of 5YR, 7.5YR, or 10YR. Texture of the B2 horizon is sandy loam, loam, or sandy clay loam. The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 5 or 6, and chroma of 2, 3, or 4. Texture is dominantly sandy loam, but there are pockets and lenses of sand, loamy sand, and gravelly loamy sand or gravelly sandy loam in some pedons. The C horizon is mildly to moderately alkaline and slightly to violently effervescent.

Finch series

The Finch series consists of somewhat poorly drained soils that have a strongly cemented subsoil. Permeability is slow in the subsoil and rapid in the rest of the soil. The soils formed in sand on outwash plains, lake plains, and till plains. Slope ranges from 0 to 4 percent.

Finch soils are similar to Au Gres soils and are commonly adjacent to Croswell and Roscommon soils. Au Gres soils do not have a continuously cemented B horizon. Croswell soils do not have mottles in the B2ir horizon. They do not have a cemented B horizon. Roscommon soils do not have a spodic horizon or a cemented B horizon.

Typical pedon of Finch sand, in an area of Au Gres-Finch sands, 0 to 4 percent slopes, 1,500 feet east and 240 feet north of SW corner of sec. 13, T. 29 N., R. 8 W.

A1—0 to 2 inches; black (10YR 2/1) sand with light gray (10YR 7/1) sand grains from the A21 scattered throughout; weak fine granular structure; very friable; many fine roots; very strongly acid; abrupt wavy boundary.

A21—2 to 10 inches; light gray (10YR 7/1) sand; few fine distinct very pale brown (10YR 7/3) mottles; single grained; loose; many fine roots; medium acid; abrupt irregular boundary.

A22—10 to 12 inches; light brownish gray (10YR 6/2) sand; common fine and medium faint light gray (10YR 7/2) and very pale brown (10YR 7/3) mottles; single grained; loose; many fine roots; medium acid; abrupt irregular boundary.

B21hirm—12 to 22 inches; very dusky red (2.5Y 2/2) and dark reddish brown (5YR 3/3) sand; common fine prominent strong brown (7.5YR 5/6) mottles; massive; strongly cemented; very few fine roots; medium acid; abrupt irregular boundary.

B22irm—22 to 31 inches; yellowish red (5YR 4/6) sand; many fine and medium distinct reddish yellow (7.5YR 6/6) mottles; massive; strongly cemented; very few fine roots; slightly acid; abrupt irregular boundary.

B3—31 to 38 inches; dark yellowish brown (10YR 4/4) sand; many fine and medium faint brown (10YR 5/3) mottles; single grained; loose; neutral; abrupt irregular wavy boundary.

C1—38 to 46 inches; yellowish brown (10YR 5/4) sand; many fine and medium faint dark brown (10YR 4/3) mottles; single grained; loose; mildly alkaline; clear wavy boundary.

C2—46 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; mildly alkaline.

The solum is 20 to 50 inches thick. It ranges from very strongly acid to neutral.

The A2 horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 1 or 2. In cultivated areas the Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. The A horizon is sand or loamy sand.

The B21hirm horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 2 or 3, and chroma of 2, 3, or 4. More than half of the horizon is cemented. The B22irm horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 2 to 4, and chroma of 2 to 6. Cementation ranges from weak to strong. The B3 horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 4 to 8. Mottles are common throughout the B horizon.

The C horizon has hue of 7.5YR, 10YR, 2.5Y, or 5Y, value of 4 to 7, and chroma of 2 to 4. It is medium acid to mildly alkaline.

Iosco series

The Iosco series consists of somewhat poorly drained, rapidly permeable over moderately slowly permeable soils on till plains, outwash plains, and lake plains. The soils formed in sandy sediments, in the underlying loamy till, and in lacustrine sediments. Slope ranges from 0 to 4 percent.

Iosco soils are similar to Au Gres, Finch, and Kawkawlin soils and are commonly adjacent to Croswell soils. The Au Gres, Croswell, and Finch soils have a sandy texture in the solum and C horizon. Finch soils, in addition, have a cemented spodic horizon. Kawkawlin soils do not have a spodic horizon, and they have loamy texture in the upper part of the solum.

Typical pedon of Iosco sand, 0 to 4 percent slopes, 330 feet south and 55 feet west of NE corner of sec. 27, T. 30 N., R. 7 W.

A1—0 to 3 inches; black (10YR 2/1) sand, grains of the A2 horizon, and leaf litter; weak medium granular structure; very friable; many fine roots; slightly acid; abrupt wavy boundary.

A2—3 to 9 inches; light brownish gray (10YR 6/2) sand; common fine faint brown (10YR 5/3) mottles; single grained; loose; common fine roots; medium acid; abrupt irregular boundary.

B21hir—9 to 15 inches; dark reddish brown (5YR 3/2) sand; common fine faint dark brown (7.5YR 3/2) and brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; common fine roots; very weakly cemented in part of pedon; strongly acid; abrupt irregular boundary.

B22ir—15 to 20 inches; brown (7.5YR 4/4) sand; common fine faint strong brown (7.5YR 5/6) mottles; single grained; very friable; few fine roots; very weakly cemented in part of pedon; strongly acid; abrupt wavy boundary.

A'2—20 to 22 inches; pinkish gray (7.5YR 6/2) loamy sand; common fine distinct strong brown (7.5YR 5/6) and brown (7.5YR 4/4) mottles;

weak fine subangular blocky structure; very friable; few fine roots; weakly cemented in part of pedon; medium acid; abrupt wavy boundary.

IIB't—22 to 25 inches; brown (7.5YR 5/4) silty clay loam; common fine distinct strong brown (7.5YR 5/8) and many fine distinct gray (N 6/0) mottles; strong medium and coarse angular blocky structure; firm; thin clay films, A'2 material on some ped surfaces; slightly acid; clear wavy boundary.

IIC—25 to 60 inches; brown (7.5YR 5/4) clay loam; many fine distinct gray (10YR 6/1) mottles; weak thick platy structure parting to moderate medium angular blocky; firm; few thin strata of sand below a depth of 48 inches; very slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. It is strongly acid to slightly acid. In cultivated areas, an Ap horizon is 6 to 9 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The texture of the A horizon is dominantly sand, but it includes loamy sand. The B21hir horizon has hue of 5YR, 7.5YR, or 10YR, value of 3, and chroma of 2 or 3. The texture of the B horizon is sand or loamy sand. The IIB't and IIC horizons are silty clay loam, clay loam, or loam.

Kalkaska series

The Kalkaska series consists of somewhat excessively drained, rapidly permeable soils on outwash plains, moraines, and old beach ridges. The soils formed in sandy glacial drift. Slope ranges from 0 to 40 percent. These soils have a thinner B21hir horizon than that in the defined range for the series. This difference does not alter the use or behavior of the soils.

Kalkaska soils are similar to Croswell, East Lake, Karlin, and Rubicon soils and are commonly adjacent to Montcalm soils. Croswell and Rubicon soils do not have a dark colored spodic horizon. East Lake soils are less acid and have a calcareous sand and gravel C horizon. Karlin soils have finer texture in the upper part of the solum and do not have a dark colored spodic horizon. Montcalm soils are finer textured throughout.

Typical pedon of Kalkaska sand, 0 to 6 percent slopes, 3,253 feet east and 75 feet north of SW corner of sec. 31, T. 29 N., R. 6 W.

A1—0 to 1 inch; black (10YR 2/1) and white (10YR 8/1) sand; single grained; loose; abundant fine roots; very strongly acid; abrupt smooth boundary.

A2—1 to 8 inches; light brownish gray (10YR 6/2) sand; single grained; loose; few fine roots; very strongly acid; abrupt irregular boundary.

B21hir—8 to 10 inches; dark reddish brown (5YR 3/2) sand; weak medium granular structure to single grained; very friable; discontinuous very weak ortstein; few fine roots; very strongly acid; abrupt irregular boundary.

B22ir—10 to 18 inches; yellowish red (5YR 4/6) sand; single grained; very friable; few fine roots; strongly acid; clear irregular boundary.

B3—18 to 34 inches; yellowish brown (10YR 5/6) sand; single grained; loose; slightly acid; clear wavy boundary.

C—34 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The solum ranges from 30 to 48 inches in thickness. In cultivated areas there is an Ap horizon 5 to 9 inches thick that has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 1 or 2. The B21hir horizon is 1 to 3 inches thick. It has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 2 or 3. The B22ir horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The B3 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 or 6. The C horizon ranges from medium acid to neutral.

Karlin series

The Karlin series consists of somewhat excessively drained, moderately rapidly permeable soils on outwash plains and moraines. The soils developed in sandy glacial drift. Slope ranges from 0 to 6 percent.

Karlin soils are similar to Croswell, East Lake, Montcalm, and Rubicon soils and are commonly adjacent to Kalkaska soils. Croswell, East Lake, and Rubicon soils do not have the finer texture in the upper part of the solum. Also, the East Lake soils are underlain by calcareous sand and gravel. Montcalm soils have an argillic horizon and a finer textured C horizon. Kalkaska soils have stronger spodic horizon development. They do not have the finer textures in the upper part of the solum.

Typical pedon of Karlin loamy fine sand, in an area of Kalkaska-Karlin complex, 0 to 6 percent slopes, 1,320 feet south and 63 feet east of NW corner of sec. 24, T. 29 N., R. 6 W.

O2—1 inch to 0; black (10YR 2/1) well decomposed leaf litter and roots with grains of the A2 horizon; weak fine granular structure; loose; strongly acid; abrupt smooth boundary.

A2—0 to 3 inches; gray (5YR 6/1) loamy fine sand; weak fine granular structure; loose; few fine roots; very strongly acid; abrupt irregular boundary.

B21ir—3 to 15 inches; dark reddish brown (5YR 3/4) loamy fine sand; weak medium subangular blocky structure; very friable; slightly hard; common fine roots; very strongly acid; clear wavy boundary.

B22ir—15 to 25 inches; dark brown (7.5YR 4/4) loamy fine sand; weak medium granular structure; very friable; slightly hard when dry; few fine roots; very strongly acid; clear wavy boundary.

B3—25 to 30 inches; brown (7.5YR 5/4) loamy sand; weak fine granular structure; loose; strongly acid; clear wavy boundary.

C—30 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The solum is 15 to 40 inches thick. It is loamy sand, loamy fine sand, or sandy loam but on the average is loamy fine sand or a coarser texture in the 10- to 40-inch control section. Cultivated areas have an Ap horizon 6 to 9 inches thick that has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. In many cultivated areas there is no A2 horizon. The B2ir horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 3 to 6. The C horizon is predominantly sand. Few thin, discontinuous bands of finer textured material are at a depth of 40 to 60 inches in some pedons.

Kawkawlin series

The Kawkawlin series consists of somewhat poorly drained, moderately slowly permeable soils on till plains and moraines. The soils developed in calcareous glacial till. Slope ranges from 0 to 3 percent.

Kawkawlin soils are similar to Charlevoix soils and are commonly adjacent to Iosco soils. Charlevoix soils are coarser textured throughout and have a spodic horizon. Iosco soils are coarser textured in the upper part of the solum and have a spodic horizon.

Typical pedon of Kawkawlin silt loam, 0 to 3 percent slopes, 2,475 feet south and 630 feet west of NE corner of sec. 29, T. 29 N., R. 9 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam; moderate fine angular blocky structure; firm; many fine roots; neutral; abrupt smooth boundary.

B&A—7 to 15 inches; brown (10YR 5/3) silty clay loam; many fine and coarse distinct strong brown (7.5YR 5/6) mottles (B2t part) with interfingering of light brownish gray (2.5Y 6/2) silty clay loam (A2 part); strong fine angular blocky structure; firm; many fine roots; neutral; clear broken boundary.

B2t—15 to 20 inches; brown (10YR 5/3) silty clay loam; many medium faint yellowish brown (10YR 5/6) mottles; strong medium angular blocky structure; very firm; continuous clay films on ped surfaces; patchy dark grayish brown (10YR 4/2) films on some surfaces; many fine roots; moderately alkaline; clear wavy boundary.

C1—20 to 25 inches; pale brown (10YR 6/3) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; firm; common fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—25 to 60 inches; pale brown (10YR 6/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; firm; segregated lime; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. If the soil has not been cultivated, it has an A1 horizon 1 to 4 inches thick that has hue of 10YR, value of 3, and chroma of 1. The A2 is a separate horizon in some pedons. It has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2. The B2t horizon is clay loam, silty clay loam, or clay. It averages from 35 to 50 percent clay. The C horizon is clay loam or silty clay loam.

Montcalm series

The Montcalm series consists of well drained, rapidly permeable soils on moraines. These soils formed in coarse textured glacial till. Slope ranges from 0 to 40 percent.

Montcalm soils are similar to Emmet and Onaway soils and are commonly adjacent to East Lake, Kalkaska, and Karlin soils. Emmet and Onaway soils have finer textured pedons. East Lake, Kalkaska, and Karlin soils do not have an argillic horizon.

Typical pedon of Montcalm loamy sand, in an area of Emmet-Montcalm complex, 3 to 12 percent slopes, 870 feet east and 410 feet north of SW corner of sec. 13, T. 31 N., R. 7 W.

O1—2 inches to 0; very dark gray (10YR 3/1) partially decomposed leaf litter; abrupt smooth boundary.

A2—0 to 3 inches; pinkish gray (7.5YR 6/2) loamy sand; weak coarse granular structure; very friable; many fine roots; medium acid; abrupt wavy boundary.

B21ir—3 to 14 inches; reddish brown (5YR 4/4) loamy sand; weak coarse granular structure; very friable; many fine roots; medium acid; clear wavy boundary.

B22ir—14 to 22 inches; dark brown (7.5YR 4/4) loamy sand; weak coarse granular structure; very friable; few fine roots; medium acid; gradual wavy boundary.

B3—22 to 31 inches; yellowish brown (10YR 5/4) loamy sand; weak coarse subangular blocky structure; very friable; few fine roots; medium acid; abrupt irregular boundary.

A'21—31 to 36 inches; light yellowish brown (10YR 6/4) loamy sand; massive; very friable; slightly acid; clear wavy boundary.

A'22 and B'21t—36 to 41 inches; light yellowish brown (10YR 6/4) loamy sand (A'22); massive; very friable; slightly acid; thick coatings on peds and intermingled with reddish brown (5YR 5/3) sandy loam (B'21t); weak coarse subangular blocky structure; firm; slightly acid; clear wavy boundary.

B22't—41 to 49 inches; reddish brown (5YR 4/3) sandy loam; weak coarse subangular blocky structure; firm; slightly acid.

C—49 to 60 inches; brown (10YR 5/3) loamy sand; massive; friable; neutral.

The solum is 48 to 66 inches thick. It is slightly to strongly acid. If the soil is cultivated, it has an Ap horizon 6 to 9 inches thick that has hue of 10YR, value of 3 or 4, and chroma of 2. The A2 horizon is absent in some pedons. The A'21 and B'22t horizons are absent as separate horizons in some pedons. The A'2 horizon is sand or loamy sand. The B'2t horizon is sandy loam, sandy clay loam, or loamy sand. The C horizon is loamy sand or sand. It ranges from neutral to moderately alkaline.

Onaway series

The Onaway series consists of well drained to moderately well drained, moderately to moderately slowly permeable soils on till plains. The soils formed in loamy calcareous till. Slope ranges from 3 to 12 percent.

Onaway soils are similar to Emmet soils and are commonly adjacent to Charlevoix soils. Emmet soils contain less clay in the control section. Charlevoix soils contain less clay and are mottled in the upper part of the solum.

Typical pedon of Onaway sandy loam, in an area of Emmet-Onaway sandy loams, 3 to 12 percent slopes, 1,320 feet west and 1,050 feet south of NE corner of sec. 1, T. 32 N., R. 9 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; friable; many fine roots; mildly alkaline; abrupt smooth boundary.

Bir—8 to 13 inches; dark brown (7.5YR 4/4) fine sandy loam; weak fine and medium subangular blocky structure; very friable; common fine roots; mildly alkaline; abrupt wavy boundary.

A2—13 to 15 inches; brown (10YR 5/3) fine sandy loam; weak fine subangular blocky structure; very friable; common fine roots; mildly alkaline; abrupt broken and wavy boundary.

B2t—15 to 23 inches; reddish brown (5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; patchy clay films on vertical faces; common fine roots; mildly alkaline; clear wavy boundary.

C—23 to 60 inches; light brown (7.5YR 6/4) loam; massive; firm; few fine roots to 30 inches; 20 percent coarse fragments below 40 inches; violent effervescence; moderately alkaline.

The solum is 15 to 30 inches thick. It is slightly acid to mildly alkaline. If the soil has not been cultivated, it has an A1 and an A2 horizon. The A1 horizon is 1 to 3 inches thick and has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The Bir horizon is sandy loam or fine sandy loam. The B2t horizon is loam, clay loam, or silty clay loam. It has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4. The C horizon is loam or sandy loam. It has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 or 4.

Pickford series

The Pickford series consists of poorly drained, very slowly permeable soils in nearly level areas and depressions on lake plains and moraines. The soils formed in fine textured calcareous lacustrine sediments or glacial till. Slope ranges from 0 to 2 percent.

Pickford soils are similar to Chestonia and Ensley soils and are adjacent to Tawas soils. Chestonia soils contain shale fragments. Ensley soils are coarser textured throughout the profile. Tawas soils have organic material 16 to 51 inches thick underlain by sandy material.

Typical pedon of Pickford silty clay loam, 600 feet east and 600 feet south of NW corner of sec. 12, T. 31 N., R. 7 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam; moderate fine and medium angular blocky structure; firm; neutral; abrupt smooth boundary.

B21g—8 to 13 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine prominent yellowish brown (10YR 5/6) and common medium distinct light olive brown (2.5Y 5/6) mottles; weak coarse angular blocky structure; firm; mildly alkaline; clear wavy boundary.

B22g—13 to 21 inches; olive gray (5Y 5/2) silty clay; many medium distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate coarse angular blocky; firm; moderately alkaline; clear wavy boundary.

B3g—21 to 30 inches; mixed greenish gray (5BG 5/1) and yellowish brown (10YR 5/6) clay; common fine faint yellowish brown (10YR 5/8) mottles; moderate medium angular blocky structure; very firm; moderately alkaline; clear wavy boundary.

C1g—30 to 41 inches; mixed greenish gray (5BG 5/1) and yellowish brown (10YR 5/6) clay; common medium prominent yellowish red (5YR 5/6) mottles; moderate and strong medium and coarse angular blocky structure; very firm; common thick greenish gray (5BG 5/1) clay films on ped faces; slight effervescence; moderately alkaline; clear wavy boundary.

C2—41 to 50 inches; greenish gray (5BG 5/1) and yellowish brown (10YR 5/6) clay loam; few fine distinct strong brown (7.5YR 5/6) and common fine and medium distinct yellowish brown mottles; weak medium subangular blocky structure; firm; slight effervescence; moderately alkaline; abrupt smooth boundary.

IIC3—50 to 60 inches; light yellowish brown (10YR 6/4) sand; common medium faint brown (10YR 5/3) mottles; single grained; loose; moderately alkaline.

The solum is 15 to 30 inches thick. The upper part of the solum ranges from slightly acid to mildly alkaline. The Ap horizon is 5 to 9 inches thick. The C horizon is mildly or moderately alkaline and slightly to strongly effervescent. The lower part of the C horizon is clay in some pedons.

Roscommon series

The Roscommon series consists of poorly drained and very poorly drained, rapidly permeable soils on outwash plains and lake plains. The soils formed in sandy glacial drift. Slope ranges from 0 to 2 percent.

The Roscommon soils are similar to Ensley soils and are commonly adjacent to Au Gres, Finch, and Tawas soils. Ensley soils are finer textured throughout. Au Gres and Finch soils have a spodic horizon. In addition, Finch soils have a cemented B horizon. Tawas soils have organic layers that are 16 to 51 inches thick.

Typical pedon of Roscommon mucky sand, 660 feet south and 830 feet east of NW corner of sec. 5, T. 30 N., R. 6 W.

A1—0 to 5 inches; black (10YR 2/1) mucky sand; weak fine granular structure; very friable; many fine roots; mildly alkaline; abrupt smooth boundary.

C1g—5 to 12 inches; gray (10YR 6/1) sand; single grained; loose; many fine roots; mildly alkaline; clear wavy boundary.

C2g—12 to 21 inches; light brownish gray (10YR 6/2) sand; few medium faint light yellowish brown (2.5Y 6/4) mottles; single grained; loose; mildly alkaline; clear irregular boundary.

C3—21 to 33 inches; mixed brown (10YR 5/3) and dark yellowish brown (10YR 4/4) sand; common fine faint light yellowish brown (10YR 6/4) mottles; single grained; loose; mildly alkaline; gradual wavy boundary.

C4—33 to 60 inches; dark brown (10YR 4/3) sand; common medium faint dark grayish brown (10YR 4/2) mottles; single grained; loose; moderately alkaline.

The soil ranges from slightly acid to mildly alkaline. If the soil is cultivated, there is an Ap horizon 6 to 10 inches thick of sand or mucky sand that has hue of 10YR, value of 2 or 3, and chroma of 1. Some undisturbed pedons have up to 10 inches of muck on the surface. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 to 4. Mottles range from faint to prominent.

Rubicon series

The Rubicon series consists of somewhat excessively drained or excessively drained, rapidly permeable to very rapidly permeable soils on outwash plains and moraines. The soils developed in sandy glacial drift. Slope ranges from 0 to 6 percent.

Rubicon soils are similar to Croswell, Deer Park, East Lake, Kalkaska, and Karlin soils and are commonly adjacent to Montcalm soils. Croswell soils have mottles in the lower part of the solum. Deer Park soils do not have a spodic horizon. East Lake soils are underlain by calcareous sand and gravel. Kalkaska soils have a more developed spodic horizon. Karlin soils are finer textured in the upper part of the solum. Montcalm soils are finer textured throughout.

Typical pedon of Rubicon sand, 0 to 6 percent slopes, 1,230 feet west and 1,185 feet south of NE corner of sec. 23, T. 29 N., R. 5 W.

A1—0 to 1 inch; black (10YR 2/1) sand and leaf litter and grains of the A2 horizon; single grained; loose; many fine roots; very strongly acid; abrupt smooth boundary.

A2—1 to 7 inches; pinkish gray (7.5YR 6/2) sand; single grained; loose; many fine roots; very strongly acid; abrupt wavy boundary.

B2ir—7 to 16 inches; dark brown (7.5YR 4/4) sand; very weak coarse granular structure; very friable; common fine roots; very strongly acid; clear wavy boundary.

B3—16 to 27 inches; brownish yellow (10YR 6/6) sand; single grained; loose; common fine roots; medium acid; clear wavy boundary.

C—27 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; few fine roots to 36 inches; discontinuous brown (7.5YR 5/4) sand bands 1 to 3 millimeters thick and 2 to 20 centimeters apart; medium acid.

The solum is 20 to 50 inches thick. It is medium acid to very strongly acid. Cultivated areas have an Ap horizon 5 to 9 inches thick that has hue of 10YR, value of 3 or 4, and chroma of 2. The B2ir horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 or 6. There are chunks of ortstein in this horizon in some pedons. The B3 horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 or 6. The C horizon has hue of 10YR, value of 6 or 7, and chroma of 3 or 4. The reaction is slightly acid or medium acid.

Tawas series

The Tawas series consists of very poorly drained, moderately slowly permeable to moderately rapidly permeable over rapidly permeable soils in bogs and on outwash plains, sandy lake plains, and moraines. The soils formed mainly in woody material underlain by sandy mineral material at a depth of 16 to 51 inches. Slope ranges from 0 to 2 percent.

Tawas soils are commonly adjacent to Roscommon soils. Roscommon soils do not have 16- to 51-inch thick organic layers.

Typical pedon of Tawas muck, 2,310 feet south and 1,485 feet east of NW corner of sec. 5, T. 30 N., R. 6 W.

Oa1—0 to 7 inches; black (5YR 2/1) broken face, rubbed and pressed sapric material; about 10 percent fiber, less than 5 percent rubbed; weak coarse granular structure; nonsticky; primarily woody and herbaceous fibers; neutral; clear smooth boundary.

Oa2—7 to 16 inches; black (5YR 2/1) broken face and rubbed, dark reddish brown (5YR 3/2) pressed sapric material; about 30 percent fiber, less than 5 percent rubbed; massive; nonsticky; primarily woody and herbaceous fibers, many partly decomposed logs; neutral; clear smooth boundary.

Oa3—16 to 25 inches; dark reddish brown (5YR 2/2) rubbed and pressed sapric material; about 30 percent fiber, less than 5 percent rubbed; massive; nonsticky; primarily woody and herbaceous fibers, many partly decomposed logs; neutral; clear smooth boundary.

Oa4—25 to 31 inches; dark reddish brown (5YR 3/3) broken face and pressed, dark reddish brown (5YR 3/2) rubbed sapric material; about 50 percent fiber, less than 10 percent rubbed; weak coarse blocky structure; nonsticky; primarily woody and herbacous fibers; mildly alkaline; abrupt smooth boundary.

IIC—31 to 60 inches; grayish brown (10YR 5/2) sand; single grained; nonsticky; mildly alkaline.

The organic layers range from 16 to 50 inches in thickness. There are partially decomposed branches, logs, and stumps throughout the solum in some pedons. The organic layers range from slightly acid to mildly alkaline. The IIC horizon is sand or loamy sand and ranges from neutral to moderately alkaline.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*6*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol.* An example is Spodosol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquods (*Aqu,* meaning water, plus *ods,* from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquods (*Hapl,* meaning minimum horizons, plus *aquods,* the suborder of Spodosols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Haplorthods.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is sandy, mixed, frigid, Typic Haplorthods.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

This section discusses the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation.

Factors of soil formation

Soil forms through the interaction of five major factors: the physical, chemical, and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the parent material.

Climate and plant and animal life are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost

entirely. Finally, time is needed for changing the parent material into a soil profile. It may be a long or short time, but some time is required for differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated mass in which a soil forms. The parent materials of the soils of Antrim County were deposited by glaciers or by melt water from the glaciers. Some of these materials are reworked and redeposited by subsequent actions of water and wind. These glaciers last covered the county about 10,000 to 12,000 years ago. Parent material determines the limits of the chemical and mineralogical composition of the soil. Although parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Antrim County were deposited as glacial till, outwash deposits, lacustrine deposits, and organic material.

Glacial till is material laid down directly by glaciers with a minimum of water action. It consists of particles of different sizes that are mixed together. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water washing. The glacial till in Antrim County is effervescent. Its texture is loamy sand, sandy loam, clay loam, or silty clay loam. Emmet soils, for example, formed in glacial till. They typically are loamy.

Outwash material is deposited by running water from melting glaciers. The size of the particles that make up outwash material varies according to the speed of the stream of water that carried them. When the water slows down, the coarser particles are deposited. Finer particles, such as very fine sand, silt, and clay, can be carried by slowly moving water. Outwash deposits generally consist of layers of particles of similar size, such as sandy loam, sand, gravel, and other coarse particles. The Kalkaska and Au Gres soils, for example, formed in deposits of outwash material in Antrim County.

Lacustrine material is deposited from still, or ponded, glacial melt water. Because the coarse fragments drop out of moving water as outwash, only the finer particles, such as very fine sand, silt, and clay remain to settle out in still water. Lacustrine deposits are silty or clayey in texture. In Antrim County, soils that formed in lacustrine deposits are predominantly fine textured. The Pickford soils, for example, formed in lacustrine materials.

Organic material is made of deposits of plant remains. After the glaciers withdrew from the area, water was left standing in depressions in outwash, lake plains, and till plains. Grasses and sedges growing around the edges of these lakes died, and their remains fell to the bottom. Because of wetness, the plant remains did not decompose but remained around the edge of the lake. Later, northern white-cedar and other water-tolerant trees grew in the areas. As these trees died, their residue became a part of the organic accumulation. Consequently, the lakes were eventually filled with organic material, and they developed into areas of muck and peat. In some of these areas, the plant remains subsequently decomposed. In other areas, the material has changed little since deposition. Tawas soils formed in organic material.

Plant and animal life

Plants have been the principal organisms influencing the soils in Antrim County, but bacteria, fungi, earthworms, and the activities of man have also been important. The chief contribution of plant and animal life is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kinds of plants that grew on the soil. The remains of these plants accumulate on the surface, decay, and eventually become organic matter. Roots of the plants provide channels for downward movement of water through the soil and also add organic matter as they decay. Bacteria in the soil help to break down organic matter so that it can be used by growing plants.

The vegetation of Antrim County was mainly mixed forests. Differences in natural soil drainage and minor changes in parent material have affected the composition of the forest.

In general, the moderately well drained or well drained upland soils, for example, the Montcalm and Emmet soils, were mainly covered with sugar maple, beech, red pine, white pine, and oak. Deer Park soils were covered with jack pine, scrub oak, and red pine. The wet soils were mainly covered with northern white-cedar and tamarack. A few wet soils have sphagnum and other mosses, which contributed substantially to the accumulation of organic matter. Tawas soils formed under wet conditions and contain considerable organic matter.

Climate

Climate is important in the formation of soils. It determines the kind of plant and animal life on and in the soil. It determines the amount of water available for weathering of minerals and transporting of soil material. Climate, through its influence on temperature in the soil, determines the rate of chemical reaction in the soil. These influences are important, and they affect large areas rather than a relatively small area, such as a county.

The climate in Antrim County is cool and humid. It is presumably similar to that which existed when the soils were being formed. The soils in Antrim County differ from soils that formed in a dry, warm climate or in a hot, moist climate. Climate is uniform throughout the county, although its effect is modified locally by the proximity to large lakes. Only minor differences in the soils of Antrim County are the result of differences in climate.

Relief

Relief, or topography, has a marked influence on the soils of Antrim County through its influence on natural drainage, erosion, plant cover, and soil temperature. In Antrim County the soils range from level to very steep, and they range from well drained in undulating to very steep areas to very poorly drained in depressions.

Relief influences the formation of soils by its effect on runoff and drainage; drainage, in turn, through its effect on aeration of the soil, determines the color of the soil. Runoff is greatest on the steeper slopes. In low areas, water is temporarily ponded. Water and air move freely through soils that are well drained to excessively drained and slowly through soils that are very poorly drained. Well-aerated soils, because of the iron and aluminum compounds that give most soils their color, are brightly colored and oxidized; poorly aerated soils are dull gray and mottled.

Kalkaska soils are somewhat excessively drained and well aerated. Tawas soils are very poorly drained and poorly aerated. All of these soils formed in similar parent materials.

Time

Time, usually a long time, is required by the agents of soil formation to form distinct horizons from parent material. The differences in length of time that the parent materials have been in place are commonly reflected in the degree of development of the soil profile. Some soils develop rapidly, others slowly.

The soils in Antrim County range from young to mature. The glacial deposits from which many of these soils formed have been exposed to soil-forming factors for a long enough time to allow prominent horizons to develop. Others have not been in place long enough for prominent horizons to develop.

Deer Park soils, for example, do not have prominent horizonation, and Kalkaska soils have prominent horizonation.

Genesis and morphology

The processes, or soil forming factors, responsible for the development of the soil horizons are referred to as soil genesis. The physical, chemical, and biological properties of the various soil horizons are termed soil morphology.

Several processes were involved in the formation of soil horizons in the soils of Antrim County. These processes are: (1) accumulation of organic matter, (2) leaching of lime (calcium carbonate) and other bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils of Antrim County, more than one of these processes have been active in the development of the horizons.

Organic matter accumulated at the surface to form an A1 horizon. The A1 horizon is mixed into a plow layer (Ap) when the soil is plowed. In the soils of Antrim County, the surface layer ranges from high to low in organic-matter content. The Ensley soils, for example, have a high organic-matter content in the surface layer, and the Deer Park soils have a low organic-matter content.

Leaching of carbonates and other bases occurred in most of the soils and this contributed to the development of horizons. For example, East Lake soils are leached of carbonates to a depth of about 30 inches.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray color in the subsoil indicates the reduction and loss of iron. Pickford soils are an example of gleying and the reduction processes. Some horizons are mottled, indicating a segregation of iron. This process has taken place in the Iosco soils.

In some soils the translocation of clay minerals has contributed to horizon development. The eluviated or leached A2 horizon above the illuviated (clay-enriched) B horizon has a platy structure, is lower in content of clay, and generally lighter in color. The B horizon generally has an accumulation of clay in pores and on the surface of peds. These soils were probably leached of carbonates and soluble salts to a considerable extent before translocation of silicate clay took place. Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in soils. The Onaway soil is an example of a soil having translocated silicate clay (in the form of clay films) accumulated in the B horizon.

In some soils of Antrim County, iron, aluminum, and humus have moved from the surface to the B horizon. The Au Gres, Kalkaska, and Finch soils, for example, contain translocated iron, aluminum, and humus.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime. Excess carbonates. Excessive carbonates, or lime, restrict the growth of some plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gypsum. Hydrous calcium sulphate.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material

of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the basis of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying

material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within 1 year; specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt water streams, in a glacial lake or other body of still water in front of a glacier.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Illustrations

Figure 1.—Typical landscape of the flat Kalkaska-East Lake-Karlin soils, in the foreground, and the hilly Kalkaska-Montcalm soils, in the background.

Figure 2.—Typical scene of the map unit Beaches along the shoreline of Lake Michigan. Deer Park sand in the background is being severely eroded by wave action. Trees are falling over onto the beach.

Figure 3.—Stripcropping is an important erosion control practice on Emmet-Montcalm complex, 3 to 12 percent slopes.

Figure 4.—Pasture on Emmet-Montcalm complex, 12 to 40 percent slopes.

Figure 5.—Rills and gullies have formed on this steep roadbank on Emmet-Onaway sandy loams, 3 to 12 percent slopes.

Figure 6.—Permanent grass vegetation helps prevent soil blowing on Kalkaska-East Lake complex, 0 to 6 percent slopes. Northern hardwoods are in the background.

Figure 7.—The bracken fern in the foreground and the red pine trees in the background are typical vegetation on the Kalkaska-Karlin complex, 0 to 6 percent slopes.

Figure 8.—Red pine trees can be used to prevent further erosion in the light colored areas in the background. This is an area of Kalkaska-Montcalm complex, 12 to 40 percent slopes.

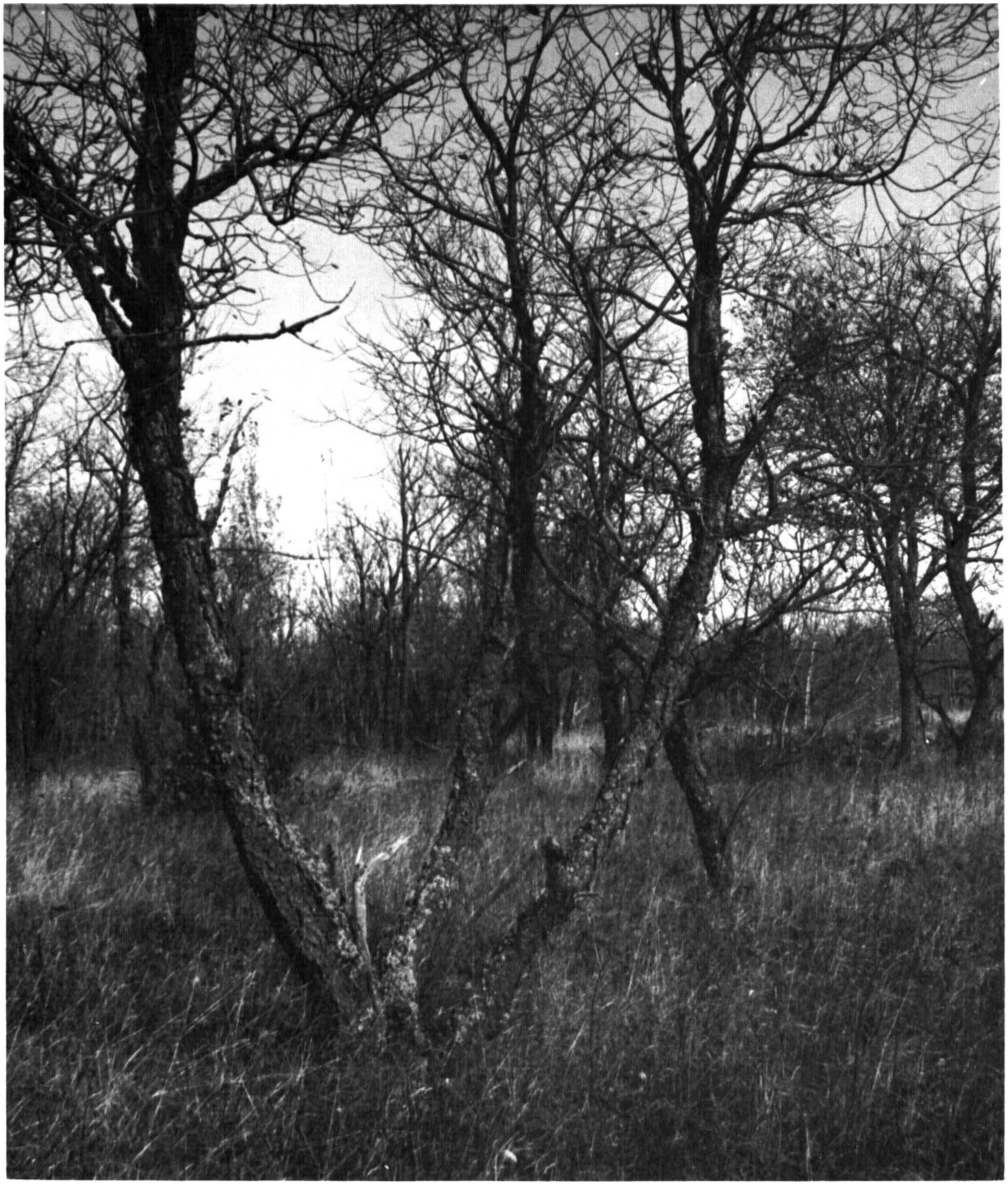

Figure 9.—Chokecherry trees on Rubicon sand, 0 to 6 percent slopes. These small trees are valuable mainly as pioneer forest cover, and the chokecherries provide food for birds and other wildlife.

Figure 10.—This stream is bordered by Tawas muck in the background. Dense stands of northern white-cedar, quaking aspen, and balsam fir grow on this soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F		In	In	In		In
January	28.7	13.7	21.2	48	-19	0	1.96	1.4	2.5	8	26.2
February	29.9	10.4	20.2	49	-23	0	1.25	.8	1.6	5	15.3
March	39.0	18.4	28.7	65	-15	3	1.46	.9	2.0	5	9.8
April	54.0	31.0	42.5	82	10	42	2.57	1.7	3.4	7	2.4
May	66.8	40.3	53.5	87	21	180	2.84	1.7	3.8	7	.2
June	76.4	50.4	63.4	94	31	412	3.09	1.6	4.4	6	0
July	80.2	54.8	67.5	93	37	550	3.20	2.0	4.3	6	0
August	78.5	54.2	66.3	94	35	514	2.94	1.5	4.2	6	0
September	70.1	47.6	58.8	90	28	287	4.15	2.5	5.6	9	T
October	61.0	40.1	50.6	82	21	124	2.67	1.4	3.8	7	.6
November	44.5	30.2	37.3	68	7	11	3.10	2.1	4.1	10	11.6
December	32.8	19.9	26.3	57	-10	0	2.19	1.5	2.8	8	23.8
Year	55.2	34.2	44.7	96	-25	2,123	31.43	28.5	34.3	85	89.9

[1]Recorded in the period 1946-1975 at East Jordan.

[2]A growing degree day is an index of the amount of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 16	May 29	June 13
2 years in 10 later than--	May 11	May 24	June 9
5 years in 10 later than--	April 30	May 16	May 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 11	September 22	September 7
2 years in 10 earlier than--	October 18	September 29	September 13
5 years in 10 earlier than--	October 31	October 12	September 24

[1]Recorded in the period 1930-1974 at East Jordan.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	158	124	94
8 years in 10	167	132	102
5 years in 10	183	148	117
2 years in 10	200	164	133
1 year in 10	208	172	141

[1]Recorded in the period 1930-1974 at East Jordan.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
AuA	Au Gres-Finch sands, 0 to 4 percent slopes	3,181	1.0
Be	Beaches	128	*
CbA	Charlevoix sandy loam, 0 to 4 percent slopes	3,255	1.1
CcB	Chestonia silty clay loam, 3 to 12 percent slopes	544	0.2
CcD	Chestonia silty clay loam, 12 to 40 percent slopes	753	0.2
CdA	Croswell sand, 0 to 4 percent slopes	3,291	1.1
DeC	Deer Park sand, 2 to 20 percent slopes	2,544	0.8
DrC	Deer Park-Roscommon complex, 0 to 20 percent slopes	1,849	0.6
EaB	East Lake gravelly loamy sand, 0 to 6 percent slopes	785	0.3
EmB	Emmet-Montcalm complex, 3 to 12 percent slopes	28,076	9.2
EmD	Emmet-Montcalm complex, 12 to 40 percent slopes	29,770	9.8
EoB	Emmet-Onaway sandy loams, 3 to 12 percent slopes	13,117	4.3
IoA	Iosco sand, 0 to 4 percent slopes	786	0.3
KaB	Kalkaska sand, 0 to 6 percent slopes	4,348	1.4
KcD	Kalkaska sand, 12 to 40 percent slopes	2,413	0.8
KeB	Kalkaska-East Lake complex, 0 to 6 percent slopes	39,283	12.8
KeD	Kalkaska-East Lake complex, 6 to 40 percent slopes	1,703	0.6
KkB	Kalkaska-Karlin complex, 0 to 6 percent slopes	23,949	7.8
KmB	Kalkaska-Montcalm complex, 0 to 12 percent slopes	29,821	9.8
KmD	Kalkaska-Montcalm complex, 12 to 40 percent slopes	68,187	22.2
KsA	Kawkawlin silt loam, 0 to 3 percent slopes	241	0.1
Ps	Pickford silty clay loam	1,292	0.4
Pt	Pits	265	0.1
Ro	Roscommon mucky sand	3,255	1.1
RuB	Rubicon sand, 0 to 6 percent slopes	6,296	2.1
Ta	Tawas muck	12,192	4.0
Te	Tawas-Ensley complex	20,610	6.8
	Water	3,346	1.1
	Total	305,280	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management. The estimates were made in 1977. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Cherries
	Bu	Ton	Bu	Bu	Ton	Ton
AuA: Au Gres-Finch	49	9	43	24	2.2	---
Be*. Beaches						
CbA: Charlevoix	80	15	80	35	3.5	---
CcB: Chestonia	---	---	70	---	3.5	---
CcD: Chestonia	---	---	---	---	---	---
CdA: Croswell	---	---	40	25	2.5	---
DeC: Deer Park	---	---	---	---	---	---
DrC: Deer Park-Roscommon	---	---	---	---	---	---
EaB: East Lake	45	7	35	18	1.8	---
EmB: Emmet-Montcalm	70	14	58	31	3.3	8
EmD: Emmet-Montcalm	---	---	---	---	3.0	---
EoB: Emmet-Onaway	85	15	70	40	3.8	6
IoA: Iosco	80	15	75	40	3.5	---
KaB: Kalkaska	45	7	35	18	1.8	---
KcD: Kalkaska	---	---	---	---	---	---
KeB: Kalkaska-East Lake	45	7	35	18	1.8	---
KeD: Kalkaska-East Lake	---	---	---	---	1.6	---
KkB: Kalkaska-Karlin	56	10	46	22	2.3	---
KmB: Kalkaska-Montcalm	50	8	45	20	2.2	---
KmD: Kalkaska-Montcalm	---	---	---	---	2.0	---
KsA: Kawkawlin	85	16	80	42	3.6	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Cherries
	Bu	Ton	Bu	Bu	Ton	Ton
Ps-------------------------- Pickford	---	---	75	---	3.0	---
Pt*. Pits						
Ro-------------------------- Roscommon	---	---	---	---	---	---
RuB------------------------- Rubicon	---	---	---	---	---	---
Ta-------------------------- Tawas	---	---	---	---	---	---
Te-------------------------- Tawas-Ensley	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I	---	---	---	---	---
II	16,613	---	3,496	13,117	---
III	30,698	28,620	2,078	---	---
IV	138,544	29,770	3,181	105,593	---
V	---	---	---	---	---
VI	111,293	753	74,483	36,057	---
VII	4,393	---	---	4,393	---
VIII	---	---	---	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Potential productivity: Common trees	Site index	Trees to plant
AuA*:								
Au Gres	Slight	Moderate	Severe	Slight	Slight	Quaking aspen	60	White spruce, black spruce.
						Bigtooth aspen	---	
						Balsam fir	---	
						Paper birch	---	
						Sugar maple	---	
						Red maple	---	
						Eastern hemlock	---	
Finch	Slight	Moderate	Severe	Moderate	Slight	Quaking aspen	45	
						Northern white-cedar	---	
						Black spruce	---	
						Red maple	---	
CbA: Charlevoix	Slight	Slight	Slight	Slight	Moderate	Sugar maple	61	White spruce.
						Paper birch	---	
						Balsam fir	---	
						White spruce	---	
						Northern white-cedar	---	
						Balsam poplar	---	
						Eastern hemlock	---	
						Quaking aspen	---	
						Black ash	---	
CcB: Chestonia	Slight	Moderate	Slight	Slight	Moderate	Sugar maple	62	White spruce, Norway spruce, northern white-cedar.
						Red maple	---	
						American elm	---	
						Northern white-cedar	---	
						Eastern hemlock	---	
						Quaking aspen	---	
						Paper birch	---	
CcD: Chestonia	Moderate	Moderate	Moderate	Slight	Moderate	Sugar maple	62	White spruce, Norway spruce, northern white-cedar.
						Red maple	---	
						American elm	---	
						Northern white-cedar	---	
						Eastern hemlock	---	
						Quaking aspen	---	
						Paper birch	---	
CdA: Croswell	Slight	Slight	Severe	Slight	Severe	Red pine	61	Red pine.
						Quaking aspen	70	
						Jack pine	65	
						Northern red oak	---	
						Black cherry	---	
						Eastern white pine	---	
						Bigtooth aspen	---	
						Sugar maple	---	
DeC: Deer Park	Slight	Slight	Severe	Slight	Severe	Red pine	61	Red pine, eastern white pine.
						Jack pine	---	
						Eastern white pine	---	
						Northern red oak	---	
						American beech	---	
						Quaking aspen	---	
						Paper birch	---	
						Black cherry	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
DrC*:								
Deer Park	Slight	Slight	Severe	Slight	Severe	Red pine	61	Red pine, eastern white pine.
						Jack pine	---	
						Eastern white pine	---	
						Northern red oak	---	
						American beech	---	
						Quaking aspen	---	
						Paper birch	---	
						Black cherry	---	
Roscommon	Slight	Severe	Severe	Moderate	Severe	Quaking aspen	45	
						Black spruce	46	
						Northern white-cedar	---	
						Jack pine	42	
						Silver maple	---	
						Red maple	---	
						Yellow birch	---	
						Balsam fir	---	
						Eastern hemlock	---	
EaB East Lake	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	61	
						Jack pine	---	
						Paper birch	---	
EmB*:								
Emmet	Slight	Slight	Slight	Slight	Moderate	Sugar maple	61	White spruce, red pine.
						Yellow birch	---	
						Red pine	---	
						American basswood	---	
						American beech	---	
						Quaking aspen	75	
						Eastern white pine	---	
						American basswood	---	
						Northern red oak	---	
Montcalm	Slight	Slight	Moderate	Slight	Moderate	Sugar maple	61	Red pine.
						Yellow birch	---	
						Quaking aspen	---	
						Eastern white pine	---	
						Eastern hemlock	---	
						American beech	---	
						Black ash	---	
EmD*:								
Emmet	Moderate	Moderate	Slight	Slight	Moderate	Sugar maple	61	White spruce, red pine.
						Yellow birch	---	
						Red pine	---	
						American basswood	---	
						American beech	---	
						Quaking aspen	75	
						Eastern white pine	---	
						American basswood	---	
						Northern red oak	---	
Montcalm	Moderate	Moderate	Moderate	Slight	Moderate	Sugar maple	61	Red pine.
						Yellow birch	---	
						Quaking aspen	---	
						Eastern white pine	---	
						Eastern hemlock	---	
						American beech	---	
						Black ash	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
EoB*:								
Emmet	Slight	Slight	Slight	Slight	Moderate	Sugar maple	61	White spruce, red pine.
						Yellow birch	---	
						Red pine	---	
						American basswood	---	
						American beech	---	
						Quaking aspen	75	
						Eastern white pine	---	
						American basswood	---	
						Northern red oak	---	
Onaway	Slight	Slight	Slight	Slight	Moderate	Sugar maple	61	White spruce, eastern white pine.
						Quaking aspen	---	
						Balsam fir	---	
						Yellow birch	---	
						Northern red oak	---	
						Red pine	---	
						American basswood	---	
						White ash	---	
IoA Iosco	Slight	Moderate	Severe	Slight	Slight	Quaking aspen	60	White spruce, black spruce.
						White ash	---	
						Sugar maple	---	
						Red maple	---	
						Yellow birch	---	
						Northern pin oak	---	
KaB Kalkaska	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
KcD Kalkaska	Moderate	Severe	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
KeB*:								
Kalkaska	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
East Lake	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	61	
						Jack pine	---	
						Paper birch	---	
KeD*:								
Kalkaska	Moderate	Moderate	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
KeD*:								
East Lake	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	61	
						Jack pine	---	
						Paper birch	---	
KkB*:								
Kalkaska	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
Karlin	Slight	Slight	Moderate	Slight	Moderate	Sugar maple	61	Red pine.
						Red maple	---	
						Yellow birch	---	
						Bigtooth aspen	---	
						Northern red oak	---	
						American basswood	---	
						American beech	---	
						Red pine	---	
						Eastern white pine	---	
KmB*:								
Kalkaska	Slight	Slight	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
Montcalm	Slight	Slight	Moderate	Slight	Moderate	Sugar maple	61	Red pine.
						Yellow birch	---	
						Quaking aspen	---	
						Eastern white pine	---	
						Eastern hemlock	---	
						American beech	---	
						Black ash	---	
KmD*:								
Kalkaska	Moderate	Moderate	Moderate	Slight	Slight	Sugar maple	53	Red pine, jack pine, eastern white pine.
						Quaking aspen	70	
						Red pine	61	
						Eastern white pine	65	
						American beech	---	
						Paper birch	54	
Montcalm	Moderate	Moderate	Moderate	Slight	Moderate	Sugar maple	61	Red pine.
						Yellow birch	---	
						Quaking aspen	---	
						Eastern white pine	---	
						Eastern hemlock	---	
						American beech	---	
						Black ash	---	
KsA Kawkawlin	Slight	Moderate	Slight	Slight	Moderate	Sugar maple	61	White spruce, red pine.
						Northern red oak	---	
						Swamp white oak	---	
						Red maple	---	
						White ash	---	
						Shagbark hickory	---	
						American basswood	---	
						Quaking aspen	---	
						Bigtooth aspen	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
Ps: Pickford	Slight	Severe	Severe	Severe	Severe	Balsam fir	45	White spruce.
						White spruce	45	
						Paper birch	---	
						Eastern hemlock	---	
						Quaking aspen	---	
						Northern white-cedar	---	
Ro: Roscommon	Slight	Severe	Severe	Moderate	Severe	Quaking aspen	45	
						Black spruce	46	
						Northern white-cedar	---	
						Jack pine	42	
						Silver maple	---	
						Red maple	---	
						Yellow birch	---	
						Balsam fir	---	
						Eastern hemlock	---	
RuB: Rubicon	Slight	Slight	Severe	Slight	Moderate	Red pine	61	Red pine, eastern white pine, jack pine.
						Eastern white pine	53	
						Balsam fir	40	
						Jack pine	45	
						Northern red oak	56	
						Quaking aspen	60	
Ta: Tawas	Slight	Severe	Severe	Severe	Severe	Balsam fir	40	
						Northern white-cedar	---	
						Quaking aspen	---	
						Black ash	---	
						Silver maple	---	
Te*:								
Tawas	Slight	Severe	Severe	Severe	Severe	Balsam fir	40	
						Northern white-cedar	---	
						Quaking aspen	---	
						Black ash	---	
						Silver maple	---	
Ensley	Slight	Severe	Severe	Severe	Severe	Balsam fir	45	White spruce.
						White spruce	---	
						White ash	---	
						Silver maple	---	
						Red maple	---	
						Yellow birch	---	
						Sugar maple	---	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
AuA*:				
Au Gres	White spruce, silky dogwood, American cranberrybush.	Black spruce, northern white-cedar, jack pine.	Eastern white pine	---
Finch	White spruce, silky dogwood.	Black spruce, northern white-cedar.	Eastern white pine	---
Be*. Beaches				
CbA Charlevoix	White spruce, American cranberrybush, Amur honeysuckle, silky dogwood, nannyberry viburnum.	Northern white-cedar, tall purple willow, black spruce.	Red pine, Scotch pine	Red maple.
CcB, CcD Chestonia	White spruce, arrowwood.	Eastern white pine	---	Red maple.
CdA Croswell	Lilac, arrowwood	American mountainash	Red pine, jack pine, red maple.	---
DeC Deer Park	Tatarian honeysuckle	Siberian crabapple, hawthorn.	Red pine, jack pine	---
DrC*:				
Deer Park	Tatarian honeysuckle	Siberian crabapple, hawthorn.	Red pine, jack pine	---
Roscommon	Arrowwood, hawthorn, Amur privet, nannyberry viburnum, silky dogwood, tamarack, whitebelle honeysuckle.	Eastern white pine, black spruce, northern white-cedar.	---	Carolina poplar.
EaB East Lake	Nannyberry viburnum, lilac.	Red pine, white spruce, jack pine, Siberian crabapple.	---	---
EmB*, EmD*:				
Emmet	White spruce, arrowwood, lilac, blue spruce, Amur honeysuckle.	Red pine	---	Red maple.
Montcalm	White spruce, Siberian crabapple, nannyberry viburnum.	Red pine	---	Carolina poplar.
EoB*:				
Emmet	White spruce, arrowwood, lilac, blue spruce, Amur honeysuckle.	Red pine	Norway spruce	Red maple.
Onaway	White spruce, blue spruce, lilac.	Red pine, black spruce	Eastern white pine	---
IoA Iosco	White spruce, black spruce.	Northern white-cedar	Red pine	White ash.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- 8-15	16-25	26-35	>35
KaB, KcD: Kalkaska	Autumn-olive, Tatarian honeysuckle.	Red pine, jack pine, eastern white pine.	---	---
KeB*, KeD*:				
Kalkaska	Autumn-olive, Tatarian honeysuckle.	Red pine, jack pine, eastern white pine.	---	---
East Lake	Nannyberry viburnum, lilac.	White spruce, jack pine, Siberian crabapple.	Red pine	---
KkB*:				
Kalkaska	Autumn-olive, Tatarian honeysuckle.	Red pine, jack pine, eastern white pine.	---	---
Karlin	---	Red pine, American mountainash, Siberian crabapple, hawthorn.	---	---
KmB*, KmD*:				
Kalkaska	Autumn-olive, Tatarian honeysuckle.	Red pine, jack pine, eastern white pine.	---	---
Montcalm	White spruce, Siberian crabapple, nannyberry viburnum.	Red pine	---	Carolina poplar.
KsA: Kawkawlin	White spruce, blue spruce, arrowwood, lilac.	Red pine, Scotch pine, jack pine.	---	Red maple.
Ps: Pickford	White spruce, silky dogwood.	Black spruce, red maple, eastern white pine.	---	---
Pt*. Pits				
Ro: Roscommon	Arrowwood, hawthorn, Amur privet, nannyberry viburnum, silky dogwood, tamarack, whitebelle honeysuckle.	Eastern white pine, black spruce, northern white-cedar. white-cedar.	---	Carolina poplar.
RuB: Rubicon	Autumn-olive	Eastern white pine	Red pine	---
Ta: Tawas	Silky dogwood, black spruce, white spruce, Amur honeysuckle.	Austrian pine, medium purple willow.	Northern white-cedar, eastern white pine, Norway spruce.	Carolina poplar.
Te*:				
Tawas	Silky dogwood, black spruce, white spruce, Amur honeysuckle.	Austrian pine, medium purple willow.	Northern white-cedar, eastern white pine, Norway spruce.	Carolina poplar.
Ensley	White spruce, hawthorn, arrowwood, shadblow serviceberry, silky dogwood.	Northern white-cedar, black spruce.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
AuA*:					
Au Gres	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Finch	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Be*. Beaches					
CbA Charlevoix	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, wetness.
CcB Chestonia	Severe: wetness, too clayey.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: low strength, wetness.
CcD Chestonia	Severe: slope, too clayey, wetness.	Severe: slope, wetness, low strength.	Severe: slope, wetness, low strength.	Severe: slope, wetness, low strength.	Severe: slope, low strength, wetness.
CdA Croswell	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Slight.
DeC Deer Park	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
DrC*:					
Deer Park	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Roscommon	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
EaB East Lake	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
EmB*:					
Emmet	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Montcalm	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
EmD*:					
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
EoB*:					
Emmet	Moderate: wetness.	Slight	Moderate: wetness.	Moderate: slope.	Moderate: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
EoB*:					
Onaway	Moderate: wetness.	Slight	Moderate: wetness.	Moderate: slope, frost action.	Moderate: low strength, frost action.
IoA Iosco	Severe: wetness, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, frost action.
KaB Kalkaska	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
KcD Kalkaska	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
KeB*:					
Kalkaska	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
East Lake	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
KeD*:					
Kalkaska	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
East Lake	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
KkB*:					
Kalkaska	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Karlin	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
KmB*:					
Kalkaska	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Montcalm	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
KmD*:					
Kalkaska	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
KsA Kawkawlin	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: frost action, low strength, wetness.
Ps Pickford	Severe: wetness, too clayey, floods.	Severe: wetness, low strength, floods.	Severe: wetness, low strength, floods.	Severe: wetness, low strength, floods.	Severe: wetness, low strength, floods.
Pt*. Pits					

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ro: Roscommon	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
RuB: Rubicon	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Ta: Tawas	Severe: excess humus, wetness, cutbanks cave.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.
Te*:					
Tawas	Severe: excess humus, wetness, cutbanks cave.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.
Ensley	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.

* See description of the map unit for the composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "severe," "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
AuA*:					
Au Gres	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, wetness, seepage.
Finch	Severe: cemented pan, wetness.	Severe: wetness, seepage.	Severe: seepage, cemented pan.	Severe: wetness, seepage.	Poor: too sandy, wetness.
Be*. Beaches					
CbA Charlevoix	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
CcB Chestonia	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
CcD Chestonia	Severe: percs slowly, wetness, slope.	Severe: slope.	Severe: too clayey, wetness.	Severe: slope, wetness.	Poor: too clayey, slope.
CdA Croswell	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
DeC Deer Park	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
DrC*:					
Deer Park	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Roscommon	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
EaB East Lake	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
EmB*:					
Emmet	Slight	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Good.
Montcalm	Slight	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
EmD*:					
Emmet	Severe: slope.	Severe: slope, seepage.	Severe: seepage.	Severe: slope, seepage.	Poor: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
EmD*:					
Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: slope, too sandy.
EoB*:					
Emmet	Severe: wetness.	Severe: seepage, wetness, slope.	Severe: seepage, wetness.	Severe: seepage, wetness.	Good.
Onaway	Severe: wetness.	Severe: wetness, slope.	Severe: wetness.	Severe: wetness.	Good.
IoA Iosco	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness, too sandy.	Severe: wetness, seepage.	Poor: too sandy.
KaB Kalkaska	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
KcD Kalkaska	Severe: slope.	Severe: slope, seepage.	Severe: slope, seepage, too sandy.	Severe: slope, seepage.	Poor: slope, too sandy.
KeB*:					
Kalkaska	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
East Lake	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
KeD*:					
Kalkaska	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
East Lake	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
KkB*:					
Kalkaska	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Karlin	Slight	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy.
KmB*:					
Kalkaska	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Montcalm	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
KmD*:					
Kalkaska	Severe: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: slope, seepage.	Poor: slope, too sandy.
Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: slope, too sandy.
KsA: Kawkawlin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, hard to pack.
Ps: Pickford	Severe: wetness, percs slowly, floods.	Slight	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: wetness, too clayey.
Pt*. Pits					
Ro: Roscommon	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
RuB: Rubicon	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Ta: Tawas	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: floods, wetness, seepage.	Poor: too sandy, wetness, seepage.
Te*:					
Tawas	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, seepage.	Severe: floods, wetness, seepage.	Poor: too sandy, wetness, seepage.
Ensley	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, floods.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
AuA*:				
Au Gres	Poor: wetness.	Good	Unsuited: excess fines.	Poor: too sandy, wetness.
Finch	Poor: wetness.	Good	Unsuited: excess fines.	Poor: too sandy, wetness.
Be*. Beaches				
CbA Charlevoix	Fair: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
CcB Chestonia	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
CcD Chestonia	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
CdA Croswell	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
DeC Deer Park	Good	Good	Unsuited: excess fines.	Poor: too sandy.
DrC*:				
Deer Park	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Roscommon	Poor: wetness.	Good	Unsuited: excess fines.	Poor: wetness, too sandy.
EaB East Lake	Good	Good	Good	Poor: small stones.
EmB*:				
Emmet	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
EmD*:				
Emmet	Poor: slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Montcalm	Poor: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: slope.
EoB*:				
Emmet	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Onaway	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
IoA Iosco	Poor: wetness.	Poor: thin layer.	Unsuited: excess fines.	Poor: too sandy.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
KaB: Kalkaska	Good	Good	Unsuited: excess fines.	Poor: too sandy.
KcD: Kalkaska	Poor: slope.	Good	Unsuited: excess fines.	Poor: too sandy.
KeB*, KeD*:				
Kalkaska	Good	Good	Unsuited: excess fines.	Poor: too sandy.
East Lake	Good	Good	Good	Poor: small stones.
KkB*:				
Kalkaska	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Karlin	Good	Good	Unsuited: excess fines.	Fair: too sandy.
KmB*:				
Kalkaska	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
KmD*:				
Kalkaska	Fair: slope.	Good	Unsuited: excess fines.	Poor: too sandy.
Montcalm	Fair: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: slope.
KsA: Kawkawlin	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ps: Pickford	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, thin layer.
Pt*. Pits				
Ro: Roscommon	Poor: wetness.	Good	Unsuited: excess fines.	Poor: wetness, too sandy.
RuB: Rubicon	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Ta: Tawas	Poor: wetness, low strength.	Good	Unsuited: excess fines.	Poor: wetness, excess humus.
Te*:				
Tawas	Poor: wetness, low strength.	Good	Unsuited: excess fines.	Poor: wetness, excess humus.
Ensley	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.

* See description of the map unit for the composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
AuA*:						
Au Gres	Seepage	Seepage	Favorable	Favorable	Wetness, too sandy, soil blowing.	Droughty, wetness.
Finch	Seepage	Seepage	Slow refill	Cemented pan	Cemented pan, wetness, too sandy.	Droughty, wetness, rooting depth.
Be*. Beaches						
CbA Charlevoix	Seepage	Piping, wetness.	Slow refill	Frost action	Not needed	Wetness.
CcB Chestonia	Slope	Hard to pack, wetness.	Slow refill	Percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
CcD Chestonia	Slope	Hard to pack, wetness.	Slow refill	Percs slowly, slope.	Slope, erodes easily, wetness.	Wetness, slope, erodes easily.
CdA Croswell	Seepage	Seepage	Deep to water	Not needed	Too sandy, soil blowing, wetness.	Droughty.
DeC Deer Park	Slope, seepage.	Seepage	No water	Not needed	Too sandy, soil blowing.	Slope, droughty.
DrC*:						
Deer Park	Slope, seepage.	Seepage	No water	Not needed	Too sandy, soil blowing.	Slope, droughty.
Roscommon	Seepage	Seepage, wetness.	Favorable	Floods	Not needed	Wetness, droughty.
EaB East Lake	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
EmB*:						
Emmet	Slope, seepage.	Piping	Slow refill	Not needed	Soil blowing	Favorable.
Montcalm	Slope, seepage.	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
EmD*:						
Emmet	Slope, seepage.	Piping	Slow refill	Not needed	Slope, soil blowing.	Slope.
Montcalm	Slope, seepage.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Droughty, slope.
EoB*:						
Emmet	Slope, seepage.	Piping	Slow refill	Not needed	Soil blowing	Favorable.
Onaway	Slope, seepage.	Favorable	Slow refill	Slope	Soil blowing	Favorable.
IoA Iosco	Favorable	Wetness	Slow refill	Favorable	Too sandy, soil blowing.	Wetness.
KaB Kalkaska	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
KcD: Kalkaska	Seepage, slope.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Slope, droughty.
KeB*:						
Kalkaska	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
East Lake	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
KeD*:						
Kalkaska	Seepage, slope.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Slope, droughty.
East Lake	Slope, seepage.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Slope, droughty.
KkB*:						
Kalkaska	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
Karlin	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
KmB*:						
Kalkaska	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
Montcalm	Slope, seepage.	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
KmD*:						
Kalkaska	Seepage, slope.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Slope, droughty.
Montcalm	Slope, seepage.	Seepage	No water	Not needed	Slope, too sandy, soil blowing.	Droughty, slope.
KsA: Kawkawlin	Favorable	Wetness	Slow refill	Percs slowly, frost action.	Not needed	Percs slowly.
Ps: Pickford	Favorable	Hard to pack	Slow refill	Percs slowly, floods.	Not needed	Wetness, percs slowly.
Pt*. Pits						
Ro: Roscommon	Seepage	Seepage, wetness.	Favorable	Floods	Not needed	Wetness, droughty.
RuB: Rubicon	Seepage	Seepage	No water	Not needed	Too sandy, soil blowing.	Droughty.
Ta: Tawas	Seepage	Wetness, seepage.	Slow refill	Floods, frost action.	Not needed	Wetness.
Te*:						
Tawas	Seepage	Wetness, seepage.	Slow refill	Floods, frost action.	Not needed	Wetness.
Ensley	Seepage	Wetness	Favorable	Frost action, floods.	Not needed	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
AuA*:				
Au Gres	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: too sandy.
Finch	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy.
Be*. Beaches				
CbA Charlevoix	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
CcB Chestonia	Severe: percs slowly, wetness.	Moderate: wetness.	Severe: percs slowly, wetness, slope.	Moderate: wetness.
CcD Chestonia	Severe: percs slowly, wetness, slope.	Severe: slope.	Severe: percs slowly, wetness, slope.	Moderate: slope, wetness.
CdA Croswell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
DeC Deer Park	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
DrC*:				
Deer Park	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Roscommon	Severe: wetness, floods, too sandy.	Severe: wetness, too sandy.	Severe: wetness, floods, too sandy.	Severe: wetness, too sandy.
EaB East Lake	Moderate: too sandy.	Moderate: too sandy, soil blowing.	Severe: small stones.	Moderate: too sandy.
EmB*:				
Emmet	Slight	Slight	Severe: slope.	Slight.
Montcalm	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
EmD*:				
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
EoB*:				
Emmet	Slight	Slight	Severe: slope.	Slight.
Onaway	Slight	Slight	Severe: slope.	Slight.
IoA Iosco	Severe: wetness, floods, too sandy.	Severe: too sandy.	Severe: wetness, too sandy.	Severe: too sandy.
KaB Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
KcD Kalkaska	Severe: too sandy, slope.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
KeB*:				
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
East Lake	Moderate: too sandy.	Moderate: too sandy, soil blowing.	Severe: small stones.	Moderate: too sandy.
KeD*:				
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
East Lake	Moderate: slope, too sandy.	Moderate: slope, too sandy, soil blowing.	Severe: slope, small stones.	Moderate: too sandy.
KkB*:				
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Karlin	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
KmB*:				
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Montcalm	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
KmD*:				
Kalkaska	Severe: too sandy, slope.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
KsA Kawkawlin	Severe: wetness, floods.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ps: Pickford	Severe: floods, wetness, percs slowly.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
Pt*. Pits				
Ro: Roscommon	Severe: wetness, floods, too sandy.	Severe: wetness, too sandy.	Severe: wetness, floods, too sandy.	Severe: wetness, too sandy.
RuB: Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Ta: Tawas	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
Te*:				
Tawas	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
Ensley	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
AuA*:										
Au Gres	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
Finch	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
Be*. Beaches										
CbA Charlevoix	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
CcB Chestonia	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
CcD Chestonia	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
CdA Croswell	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
DeC Deer Park	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
DrC*:										
Deer Park	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Roscommon	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
EaB East Lake	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
EmB*:										
Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
EmD*:										
Emmet	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Montcalm	Very poor.	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
EoB*:										
Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Onaway	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
IoA Iosco	Poor	Poor	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
KaB Kalkaska	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.

See footnote at end of table.

TABLE 14.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
KcD: Kalkaska	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
KeB*:										
Kalkaska	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
KeD*:										
Kalkaska	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
KkB*:										
Kalkaska	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
Karlin	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
KmB*:										
Kalkaska	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
Montcalm	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
KmD*:										
Kalkaska	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Montcalm	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
KsA: Kawkawlin	Fair	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
Ps: Pickford	Poor	Good	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Pt*. Pits										
Ro: Roscommon	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
RuB: Rubicon	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
Ta: Tawas	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Very poor.	Poor	Good.
Te*:										
Tawas	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Very poor.	Poor	Good.
Ensley	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Very poor.	Poor	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
AuA*:											
Au Gres	0-6	Sand	SP, SM	A-2-4, A-3	0	95-100	90-100	60-80	0-20	---	NP
	6-24	Sand, loamy sand	SP-SM, SP, SM	A-2-4, A-3	0	95-100	90-100	60-80	0-15	---	NP
	24-60	Sand	SP, SP-SM	A-3, A-2-4	0	95-100	90-100	50-80	0-10	---	NP
Finch	0-12	Sand	SP-SM, SM	A-3, A-2-4	0	100	100	50-70	5-15	---	NP
	12-31	Sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-95	5-15	---	NP
	31-60	Sand	SP, SP-SM	A-3	0	100	100	80-95	0-10	---	NP
Be*. Beaches											
CbA Charlevoix	0-11	Sandy loam	SM, SM-SC	A-2	0-5	80-95	80-95	50-90	25-35	<29	2-7
	11-14	Sandy loam	SM, SM-SC	A-2	0-5	80-95	80-95	50-70	25-35	<29	2-7
	14-33	Sandy clay loam, loam, sandy loam.	ML, SC, SM, CL	A-6, A-4, A-2	0-5	80-95	80-95	50-90	25-55	12-38	2-19
	33-60	Sandy loam, gravelly sandy loam.	SM, SC, SM-SC	A-2	0-5	80-95	80-95	50-70	25-35	<25	3-8
CcB, CcD Chestonia	0-9	Silty clay loam	CL	A-6, A-4	0	85-95	85-95	85-95	80-90	27-37	9-16
	9-16	Clay loam, silty clay loam, silty clay.	CH, CL	A-7	0	85-95	85-95	80-95	60-90	40-75	15-50
	16-60	Clay loam, silty clay loam, shaly silty clay.	CH, GC, SC, CL	A-7	0	65-90	65-90	60-90	45-85	40-75	15-50
CdA Croswell	0-6	Sand	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	6-30	Sand	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	30-60	Sand	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
DeC Deer Park	0-9	Sand	SP, SM, SP-SM	A-2, A-3	0	100	95-100	51-80	0-30	---	NP
	9-60	Fine sand, sand	SP, SM, SP-SM	A-2, A-3	0	100	95-100	75-100	0-30	---	NP
DrC*:											
Deer Park	0-9	Sand	SP, SM, SP-SM	A-2, A-3	0	100	95-100	51-80	0-30	---	NP
	9-60	Fine sand, sand	SP, SM, SP-SM	A-2, A-3	0	100	95-100	75-100	0-30	---	NP
Roscommon	0-5	Mucky sand	SM, SP, SP-SM	A-2, A-3, A-1	0	100	90-100	40-70	0-15	---	NP
	5-60	Sand	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
EaB------------------ East Lake	0-18	Gravelly loamy sand.	SP-SM	A-1, A-2-4, A-3	0	90-100	75-85	35-65	5-15	---	NP
	18-26	Sand------------	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	80-100	40-75	5-15	---	NP
	26-60	Stratified gravelly sand to loamy sand.	GP, SP-SM, SP, GP-GM	A-1, A-3, A-2-4	0	40-90	35-85	20-60	0-10	---	NP
EmB*, EmD*:											
Emmet--------------	0-4	Sandy loam------	SM, SM-SC, SC	A-2	0-5	95-100	95-100	55-70	25-35	10-25	NP-10
	4-27	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2	0-5	95-100	90-100	55-70	15-35	10-25	NP-10
	27-41	Loam, sandy loam, sandy clay loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6	0-5	95-100	90-100	55-85	25-75	20-40	5-20
	41-60	Sandy loam------	SM, SM-SC, SC	A-2	0-5	85-95	80-90	50-70	25-35	<25	NP-10
Montcalm-----------	0-3	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	3-36	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	36-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
EoB*:											
Emmet--------------	0-4	Sandy loam------	SM, SM-SC, SC	A-2	0-5	95-100	95-100	55-70	25-35	10-25	NP-10
	4-27	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2	0-5	95-100	90-100	55-70	15-35	10-25	NP-10
	27-41	Loam, sandy loam, sandy clay loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6	0-5	95-100	90-100	55-85	25-75	20-40	5-20
	41-60	Sandy loam------	SM, SM-SC, SC	A-2	0-5	85-95	80-90	50-70	25-35	<25	NP-10
Onaway-------------	0-15	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-2, A-4	0-30	90-100	85-95	55-80	25-50	<20	NP-10
	15-23	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-20	95-100	95-100	80-95	65-90	25-35	7-15
	23-60	Silt loam, loam, sandy loam.	CL-ML, SC, CL, SM-SC	A-4	0-20	90-95	85-95	60-95	36-80	15-25	4-10
IoA------------------ Iosco	0-9	Sand------------	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-15	---	NP
	9-22	Loamy sand, sand	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-30	<20	NP-4
	22-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	65-95	20-40	5-25

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
KaB, KcD----------- Kalkaska	0-8	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	8-34	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	34-60	Sand------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
KeB*, KeD*: Kalkaska----------	0-8	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	8-34	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	34-60	Sand------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
East Lake---------	0-18	Gravelly loamy sand.	SP-SM	A-1, A-2-4, A-3	0	90-100	75-85	35-65	5-15	---	NP
	18-26	Sand------------	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	80-100	40-75	5-15	---	NP
	26-60	Stratified gravelly sand to loamy sand.	GP, SP-SM, SP, GP-GM	A-1, A-3, A-2-4	0	40-90	35-85	20-60	0-10	---	NP
KkB*: Kalkaska----------	0-8	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	8-34	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	34-60	Sand------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
Karlin------------	0-30	Loamy fine sand, loamy sand.	SM	A-2	0	90-100	85-100	50-75	20-35	---	NP-4
	30-60	Sand------------	SP-SM	A-3, A-1	0	80-100	70-100	40-70	5-10	---	NP
KmB*, KmD*: Kalkaska----------	0-8	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	8-34	Sand------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	34-60	Sand------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
Montcalm----------	0-3	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	3-36	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	36-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
KsA--------------- Kawkawlin	0-7	Silt loam-------	ML, CL	A-4, A-6	0-3	95-100	95-100	80-100	55-85	25-40	2-15
	7-20	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-3	95-100	90-100	85-100	60-90	25-55	11-30
	20-60	Clay loam, silty clay loam.	CL	A-6	0-3	95-100	90-100	85-100	60-90	25-36	11-18

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ps----------------- Pickford	0-13	Silty clay loam	CL	A-7	0	100	100	90-100	75-95	40-50	18-28
	13-50	Clay, silty clay, clay loam.	CH, CL	A-7	0	100	100	90-100	75-95	42-70	21-42
	50-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	5-15	---	NP
Pt*. Pits											
Ro----------------- Roscommon	0-5	Mucky sand-------	SM, SP, SP-SM	A-2, A-3, A-1	0	100	90-100	40-70	0-15	---	NP
	5-60	Sand-------------	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
RuB---------------- Rubicon	0-7	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	7-27	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-75	5-15	---	NP
	27-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP
Ta----------------- Tawas	0-31	Sapric material	Pt	A-8	0	---	---	---	---	---	---
	31-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	95-100	90-100	60-75	0-20	---	NP
Te*: Tawas--------------	0-31	Sapric material	Pt	A-8	0	---	---	---	---	---	---
	31-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	95-100	90-100	60-75	0-20	---	NP
Ensley------------	0-8	Mucky sandy loam	SM-SC, SM, ML, CL-ML	A-2, A-4	0-10	90-100	85-100	50-90	25-65	<25	NP-6
	8-36	Sandy loam, sandy clay loam, loam.	CL, SC	A-6	0-10	95-100	90-100	55-90	40-70	20-30	11-16
	36-60	Sandy loam, gravelly loamy sand.	SM-SC, SM	A-2	0-10	85-95	80-95	50-65	20-35	<20	NP-7

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that the data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH						
AuA*:										
Au Gres	0-6	6.0-20	0.07-0.10	4.5-7.3	Very low	Low	Moderate	0.15	5	1
	6-24	6.0-20	0.06-0.09	4.5-7.3	Very low	Low	Moderate	0.15		
	24-60	>20	0.05-0.07	5.1-6.0	Very low	Low	Moderate	0.15		
Finch	0-12	6.0-20	0.07-0.09	4.5-7.3	Low	High	Moderate	0.15	4	1
	12-31	0.06-0.2	0.02-0.04	4.5-7.3	Low	High	Moderate	0.15		
	31-60	6.0-20	0.02-0.04	5.6-7.8	Low	High	Low	0.15		
Be*. Beaches										
CbA Charlevoix	0-11	2.0-6.0	0.12-0.20	5.6-6.5	Low	Moderate	Moderate	0.20	5	3
	11-14	2.0-6.0	0.08-0.12	5.6-7.3	Low	Moderate	Moderate	0.20		
	14-33	0.6-6.0	0.12-0.18	6.1-7.3	Low	Moderate	Moderate	0.20		
	33-60	0.6-6.0	0.08-0.12	7.4-8.4	Low	Moderate	Low	0.20		
CcB, CcD Chestonia	0-9	0.06-0.2	0.16-0.18	6.1-7.3	Moderate	High	Low	0.43	3	7
	9-16	<0.06	0.14-0.18	6.1-7.3	Moderate	High	Low	0.32		
	16-60	<0.06	0.12-0.16	7.4-8.4	Moderate	High	Low	0.32		
CdA Croswell	0-6	6.0-20	0.07-0.09	4.5-6.0	Low	Low	Moderate	0.15	5	1
	6-30	6.0-20	0.06-0.08	5.1-6.5	Low	Low	Moderate	0.15		
	30-60	>20	0.05-0.07	5.6-7.3	Low	Low	Moderate	0.15		
DeC Deer Park	0-9	6.0-20	0.02-0.05	5.1-6.5	Low	Low	Low	0.15	5	1
	9-60	6.0-20	0.02-0.05	5.1-6.5	Low	Low	Low	0.15		
DrC*:										
Deer Park	0-9	6.0-20	0.02-0.05	5.1-6.5	Low	Low	Low	0.15	5	1
	9-60	6.0-20	0.02-0.05	5.1-6.5	Low	Low	Low	0.15		
Roscommon	0-5	6.0-20	0.06-0.18	6.1-7.8	Low	High	Low	0.17	5	1
	5-60	6.0-20	0.05-0.07	6.1-7.8	Low	High	Low	0.17		
EaB East Lake	0-18	6.0-20	0.04-0.08	5.6-7.3	Low	Low	Moderate	0.15	5	2
	18-26	6.0-20	0.07-0.10	5.6-7.3	Low	Low	Moderate	0.15		
	26-60	>20	0.02-0.06	7.4-8.4	Low	Low	Low	0.15		
EmB*, EmD*:										
Emmet	0-4	2.0-6.0	0.12-0.15	6.1-6.5	Low	Low	Moderate	0.20	5-4	3
	4-27	2.0-6.0	0.11-0.14	6.1-6.5	Low	Low	Moderate	0.20		
	27-41	0.6-2.0	0.11-0.18	6.6-7.8	Moderate	Low	Low	0.32		
	41-60	2.0-6.0	0.08-0.12	7.4-8.4	Low	Low	Low	0.32		
Montcalm	0-3	6.0-20	0.10-0.12	5.1-6.5	Low	Low	Moderate	0.17	5	2
	3-36	6.0-20	0.06-0.10	5.1-6.5	Low	Low	Moderate	0.17		
	36-60	6.0-20	0.04-0.13	5.1-6.5	Low	Low	Moderate	0.17		
EoB*:										
Emmet	0-4	2.0-6.0	0.12-0.15	6.1-6.5	Low	Low	Moderate	0.20	5-4	3
	4-27	2.0-6.0	0.11-0.14	6.1-6.5	Low	Low	Moderate	0.20		
	27-41	0.6-2.0	0.11-0.18	6.6-7.8	Moderate	Low	Low	0.32		
	41-60	2.0-6.0	0.08-0.12	7.4-8.4	Low	Low	Low	0.32		
Onaway	0-15	2.0-6.0	0.08-0.16	5.6-7.8	Low	Moderate	Low	0.24	5	3
	15-23	0.2-2.0	0.12-0.18	5.6-7.8	Moderate	Moderate	Low	0.32		
	23-60	0.2-2.0	0.10-0.20	7.4-8.4	Low	Moderate	Low	0.32		
IoA Iosco	0-9	6.0-20	0.07-0.09	5.1-6.5	Low	Low	Moderate	0.17	5	1
	9-22	6.0-20	0.06-0.11	5.1-6.5	Low	Low	Moderate	0.17		
	22-60	0.2-0.6	0.14-0.20	6.1-7.8	Moderate	High	Low	0.37		

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea-bility	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodi-bility group
						Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH						
KaB, KcD: Kalkaska	0-8	6.0-20	0.05-0.09	4.5-6.0	Low	Low	High	0.15	5	1
	8-34	6.0-20	0.06-0.08	4.5-6.0	Low	Low	High	0.15		
	34-60	6.0-20	0.04-0.06	5.1-6.5	Low	Low	High	0.15		
KeB*, KeD*:										
Kalkaska	0-8	6.0-20	0.05-0.09	4.5-6.0	Low	Low	High	0.15	5	1
	8-34	6.0-20	0.06-0.08	4.5-6.0	Low	Low	High	0.15		
	34-60	6.0-20	0.04-0.06	5.1-6.5	Low	Low	High	0.15		
East Lake	0-18	6.0-20	0.04-0.08	5.6-7.3	Low	Low	Moderate	0.15	5	2
	18-26	6.0-20	0.07-0.10	5.6-7.3	Low	Low	Moderate	0.15		
	26-60	>20	0.02-0.06	7.4-8.4	Low	Low	Low	0.15		
KkB*:										
Kalkaska	0-8	6.0-20	0.05-0.09	4.5-6.0	Low	Low	High	0.15	5	1
	8-34	6.0-20	0.06-0.08	4.5-6.0	Low	Low	High	0.15		
	34-60	6.0-20	0.04-0.06	5.1-6.5	Low	Low	High	0.15		
Karlin	0-30	2.0-6.0	0.08-0.12	4.5-6.0	Low	Low	High	0.17	4	2
	30-60	6.0-20	0.02-0.04	5.6-6.5	Low	Low	Moderate	0.17		
KmB*, KmD*:										
Kalkaska	0-8	6.0-20	0.05-0.09	4.5-6.0	Low	Low	High	0.15	5	1
	8-34	6.0-20	0.06-0.08	4.5-6.0	Low	Low	High	0.15		
	34-60	6.0-20	0.04-0.06	5.1-6.5	Low	Low	High	0.15		
Montcalm	0-3	6.0-20	0.10-0.12	5.1-6.5	Low	Low	Moderate	0.17	5	2
	3-36	6.0-20	0.06-0.10	5.1-6.5	Low	Low	Moderate	0.17		
	36-60	6.0-20	0.04-0.13	5.1-6.5	Low	Low	Moderate	0.17		
KsA: Kawkawlin	0-7	0.6-2.0	0.20-0.24	5.1-7.3	Low	High	Moderate	0.32	4	6
	7-20	0.2-0.6	0.10-0.20	5.1-7.8	Moderate	High	Low	0.32		
	20-60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate	High	Low	0.32		
Ps: Pickford	0-13	0.2-0.6	0.20-0.24	6.1-7.3	Moderate	High	Low	0.37	3	7
	13-50	<0.06	0.09-0.13	6.1-7.8	Moderate	High	Low	0.37		
	50-60	6.0-20	0.02-0.04	7.4-8.4	Low	High	Low	0.17		
Pt*. Pits										
Ro: Roscommon	0-5	6.0-20	0.06-0.18	6.1-7.8	Low	High	Low	0.17	5	1
	5-60	6.0-20	0.05-0.07	6.1-7.8	Low	High	Low	0.17		
RuB: Rubicon	0-7	6.0-20	0.05-0.09	4.5-6.0	Low	Low	High	0.15	5	1
	7-27	>6.0	0.04-0.08	4.5-6.0	Low	Low	High	0.15		
	27-60	>6.0	0.04-0.06	4.5-6.5	Low	Low	High	0.15		
Ta: Tawas	0-31	0.2-6.0	0.35-0.45	4.5-7.8	---	High	Moderate	---	---	3
	31-60	6.0-20	0.03-0.10	5.6-8.4	Low	High	Low	---		
Te*:										
Tawas	0-31	0.2-6.0	0.35-0.45	4.5-7.8	---	High	Moderate	---	---	3
	31-60	6.0-20	0.03-0.10	5.6-8.4	Low	High	Low	---		
Ensley	0-8	2.0-6.0	0.10-0.20	6.1-7.8	Low	High	Low	0.20	5	3
	8-36	0.6-2.0	0.10-0.18	7.4-8.4	Moderate	High	Low	0.20		
	36-60	2.0-6.0	0.08-0.12	7.4-8.4	Low	High	Low	0.20		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Cemented pan		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			In		
AuA*:										
Au Gres	B	None	---	---	0.5-1.5	Apparent	Nov-May	---	---	Moderate.
Finch	C	None	---	---	0.5-1.5	Perched	Dec-Jun	10-16	Rippable	Moderate.
Be*. Beaches										
CbA Charlevoix	B	None	---	---	0.5-1.5	Apparent	Nov-May	---	---	High.
CcB, CcD Chestonia	D	None	---	---	1.0-2.0	Perched	Nov-May	---	---	Moderate.
CdA Croswell	A	None	---	---	2.0-3.0	Apparent	Nov-Apr	---	---	Low.
DeC Deer Park	A	None	---	---	>6.0	---	---	---	---	Low.
DrC*:										
Deer Park	A	None	---	---	>6.0	---	---	---	---	Low.
Roscommon	A/D	Frequent	Brief	Sep-May	0-1.0	Apparent	Sep-Jun	---	---	Moderate.
EaB East Lake	A	None	---	---	>6.0	---	---	---	---	Low.
EmB*, EmD*:										
Emmet	B	None	---	---	>2.5	Apparent	Jan-Apr	---	---	Moderate.
Montcalm	A	None	---	---	>6.0	---	---	---	---	Low.
EoB*:										
Emmet	B	None	---	---	>2.5	Apparent	Jan-Apr	---	---	Moderate.
Onaway	B	None	---	---	>2.5	Apparent	Mar-May	---	---	Moderate.
IoA Iosco	B	Rare	---	---	1.0-2.0	Apparent	Nov-Jun	---	---	Moderate.
KaB, KcD Kalkaska	A	None	---	---	>6.0	---	---	---	---	Low.
KeB*, KeD*:										
Kalkaska	A	None	---	---	>6.0	---	---	---	---	Low.
East Lake	A	None	---	---	>6.0	---	---	---	---	Low.
KkB*:										
Kalkaska	A	None	---	---	>6.0	---	---	---	---	Low.
Karlin	A	None	---	---	>6.0	---	---	---	---	Low.
KmB*, KmD*:										
Kalkaska	A	None	---	---	>6.0	---	---	---	---	Low.
Montcalm	A	None	---	---	>6.0	---	---	---	---	Low.
KsA Kawkawlin	C	Rare	---	---	1.0-2.0	Apparent	Oct-May	---	---	High.
Ps Pickford	D	Frequent	Long	Nov-May	0-1.0	Apparent	Nov-Jun	---	---	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Cemented pan: Depth	Cemented pan: Hardness	Potential frost action
					Ft			In		
Pt*. Pits										
Ro----------------- Roscommon	A/D	Frequent----	Brief-----	Sep-May	0-1.0	Apparent	Sep-Jun	---	---	Moderate.
RuB---------------- Rubicon	A	None--------	---	---	>6.0	---	---	---	---	Low.
Ta----------------- Tawas	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-May	---	---	High.
Te*:										
Tawas-------------	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-May	---	---	High.
Ensley------------	B/D	Frequent----	Long------	Nov-May	0-0.5	Apparent	Nov-Jun	---	---	High.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Au Gres-------------------	Sandy, mixed, frigid Entic Haplaquods
Charlevoix----------------	Coarse-loamy, mixed, frigid Alfic Haplaquods
Chestonia-----------------	Fine, mixed, nonacid, frigid, sloping Aeric Haplaquepts
Croswell------------------	Sandy, mixed, frigid Entic Haplorthods
Deer Park-----------------	Mixed, frigid Spodic Udipsamments
*East Lake----------------	Sandy, mixed, frigid Typic Haplorthods
Emmet---------------------	Coarse-loamy, mixed, frigid Alfic Haplorthods
Ensley--------------------	Coarse-loamy, mixed, nonacid, frigid Aeric Haplaquepts
Finch---------------------	Sandy, mixed, frigid, ortstein Aeric Haplaquods
Iosco---------------------	Sandy over loamy, mixed, frigid Alfic Haplaquods
*Kalkaska-----------------	Sandy, mixed, frigid Typic Haplorthods
Karlin--------------------	Sandy, mixed, frigid Entic Haplorthods
Kawkawlin-----------------	Fine, mixed Aquic Eutroboralfs
Montcalm------------------	Sandy, mixed, frigid Alfic Haplorthods
Onaway--------------------	Fine-loamy, mixed, frigid Alfic Haplorthods
Pickford------------------	Fine, mixed, nonacid, frigid Aeric Haplaquepts
Roscommon-----------------	Mixed, frigid Mollic Psammaquents
Rubicon-------------------	Sandy, mixed, frigid Entic Haplorthods
Tawas---------------------	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists

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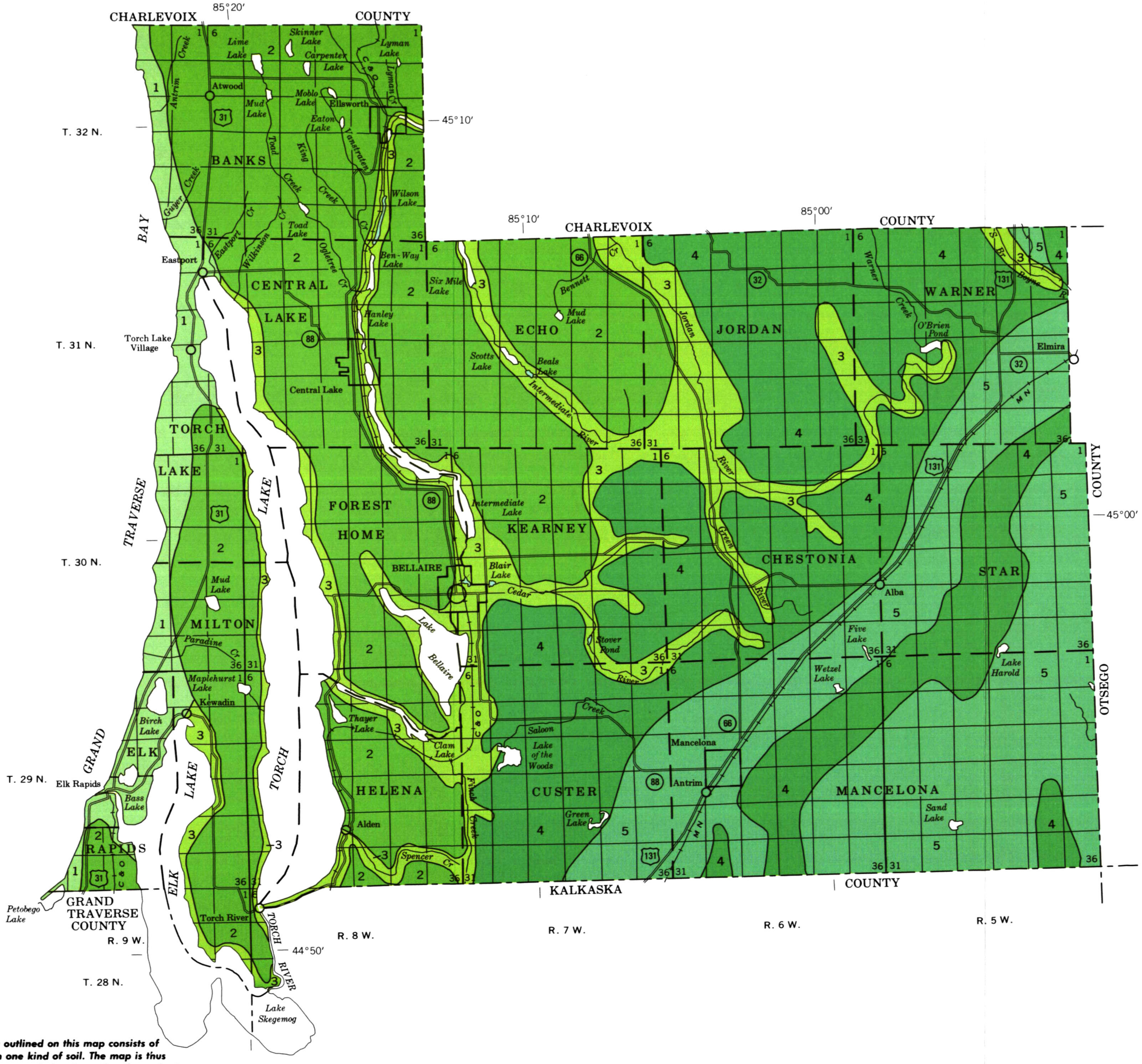
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
ANTRIM COUNTY, MICHIGAN

Scale 1:190,080



SOIL LEGEND

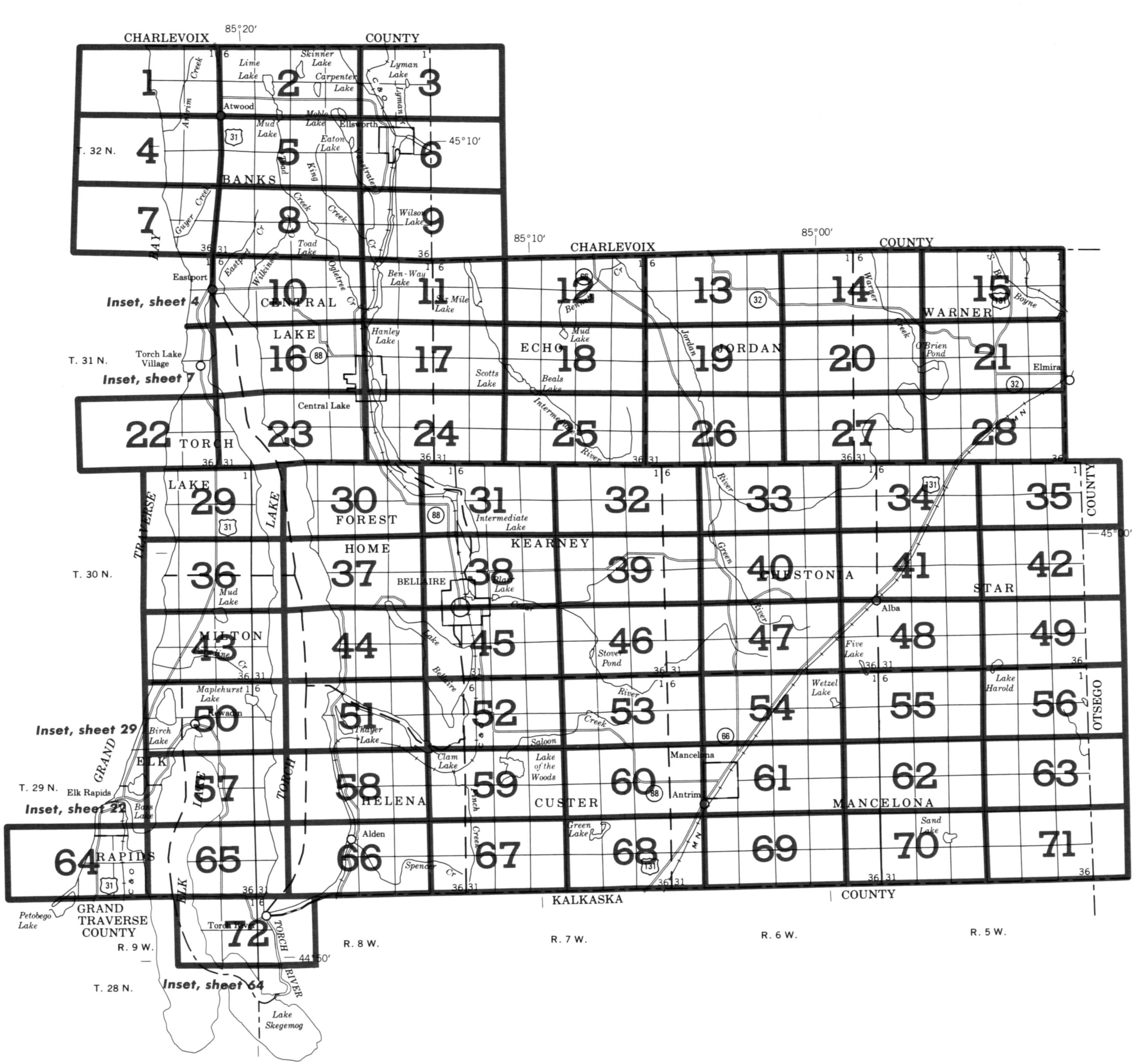
1. Deer Park–Roscommon: Excessively drained, poorly drained, and very poorly drained, level to moderately steep, sandy soils on dunes and lake plains
2. Emmet–Montcalm: Well drained and moderately well drained, gently sloping to very steep, loamy and sandy soils on knolls, ridges, and hills
3. Tawas–Ensley–Roscommon: Very poorly drained and poorly drained, nearly level, mucky, loamy, and sandy soils in depressions on plains
4. Kalkaska–Montcalm: Somewhat excessively drained and well drained, nearly level to very steep, sandy soils on hills, ridges, and knolls
5. Kalkaska–East Lake–Karlin: Somewhat excessively drained, level to very steep, sandy soils on plains

Compiled 1977

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

ANTRIM COUNTY, MICHIGAN

Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

The first capital letter is the initial one for the soil name. The lower case letter that follows separates mapping units having names that begin with the same letter, except that it does not separate sloping phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
AuA	Au Gres–Finch sands, 0 to 4 percent slopes
Be	Beaches
CbA	Charlevoix sandy loam, 0 to 4 percent slopes
CcB	Chestonia silty clay loam, 3 to 12 percent slopes
CcD	Chestonia silty clay loam, 12 to 40 percent slopes
CdA	Croswell sand, 0 to 4 percent slopes
DeC	Deer Park sand, 2 to 20 percent slopes
DrC	Deer Park–Roscommon complex, 0 to 20 percent slopes
EaB	East Lake gravelly loamy sand, 0 to 6 percent slopes
EmB	Emmet–Montcalm complex, 3 to 12 percent slopes
EmD	Emmet–Montcalm complex, 12 to 40 percent slopes
EoB	Emmet–Onaway sandy loams, 3 to 12 percent slopes
IoA	Iosco sand, 0 to 4 percent slopes
KaB	Kalkaska sand, 0 to 6 percent slopes
KcD	Kalkaska sand, 12 to 40 percent slopes
KeB	Kalkaska–East Lake complex, 0 to 6 percent slopes
KeD	Kalkaska–East Lake complex, 6 to 40 percent slopes
KkB	Kalkaska–Karlin complex, 0 to 6 percent slopes
KmB	Kalkaska–Montcalm complex, 0 to 12 percent slopes
KmD	Kalkaska–Montcalm complex, 12 to 40 percent slopes
KsA	Kawkawlin silt loam, 0 to 3 percent slopes
Ps	Pickford silty clay loam
Pt	Pits
Ro	Roscommon mucky sand
RuB	Rubicon sand, 0 to 6 percent slopes
Ta	Tawas muck
Te	Tawas–Ensley complex

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

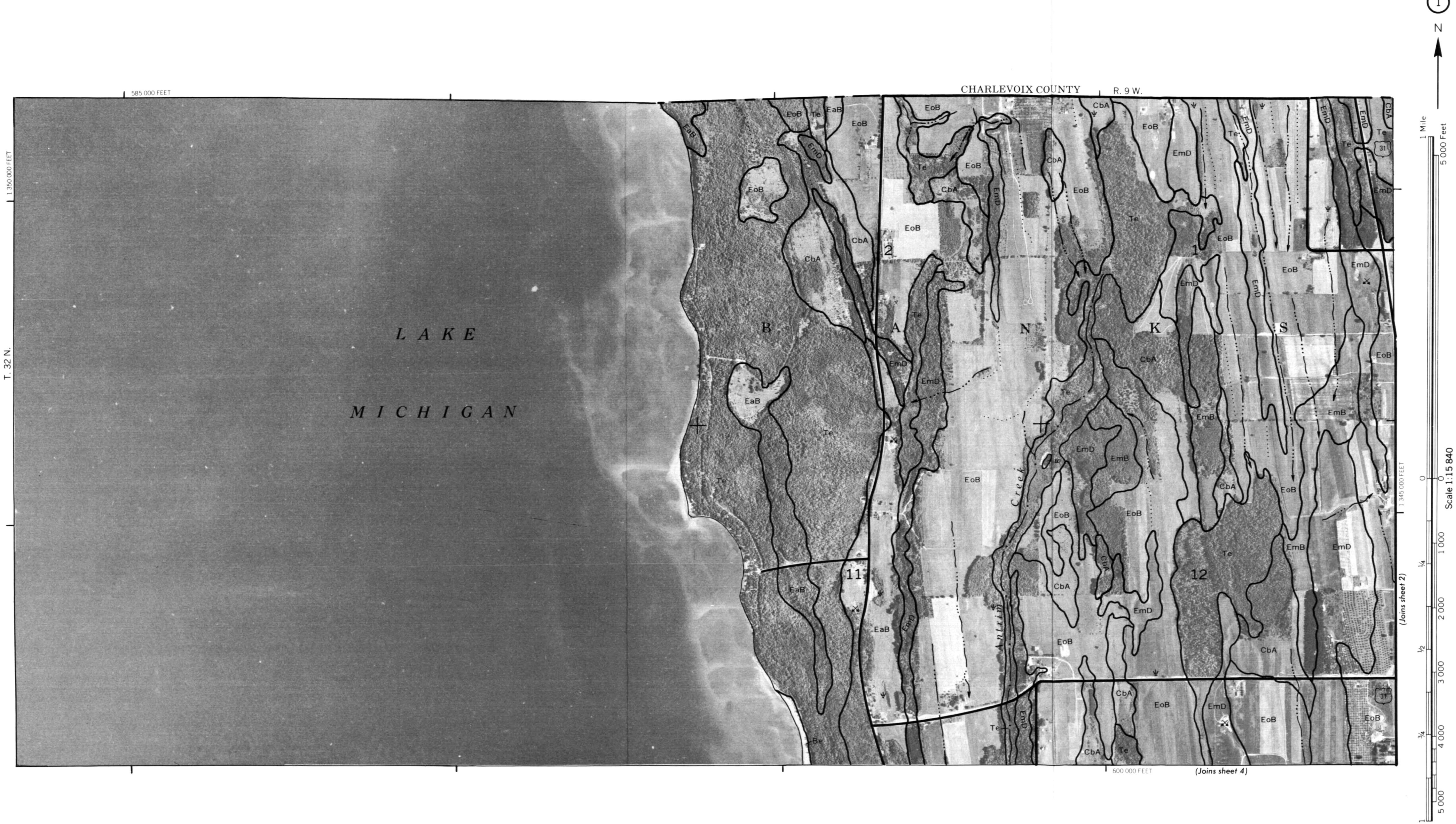
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Sanitary landfill
- Loam spot



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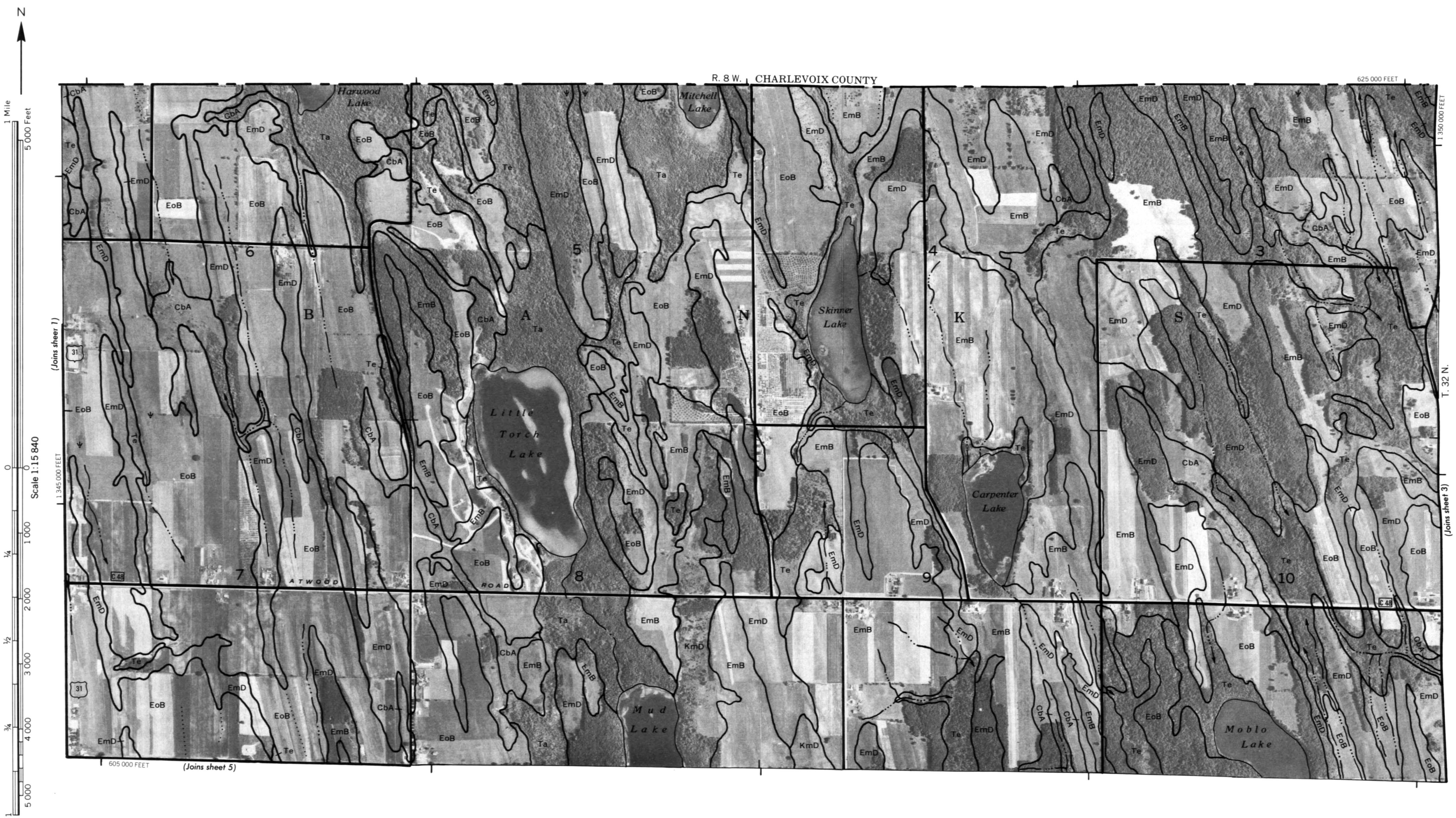
ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 2



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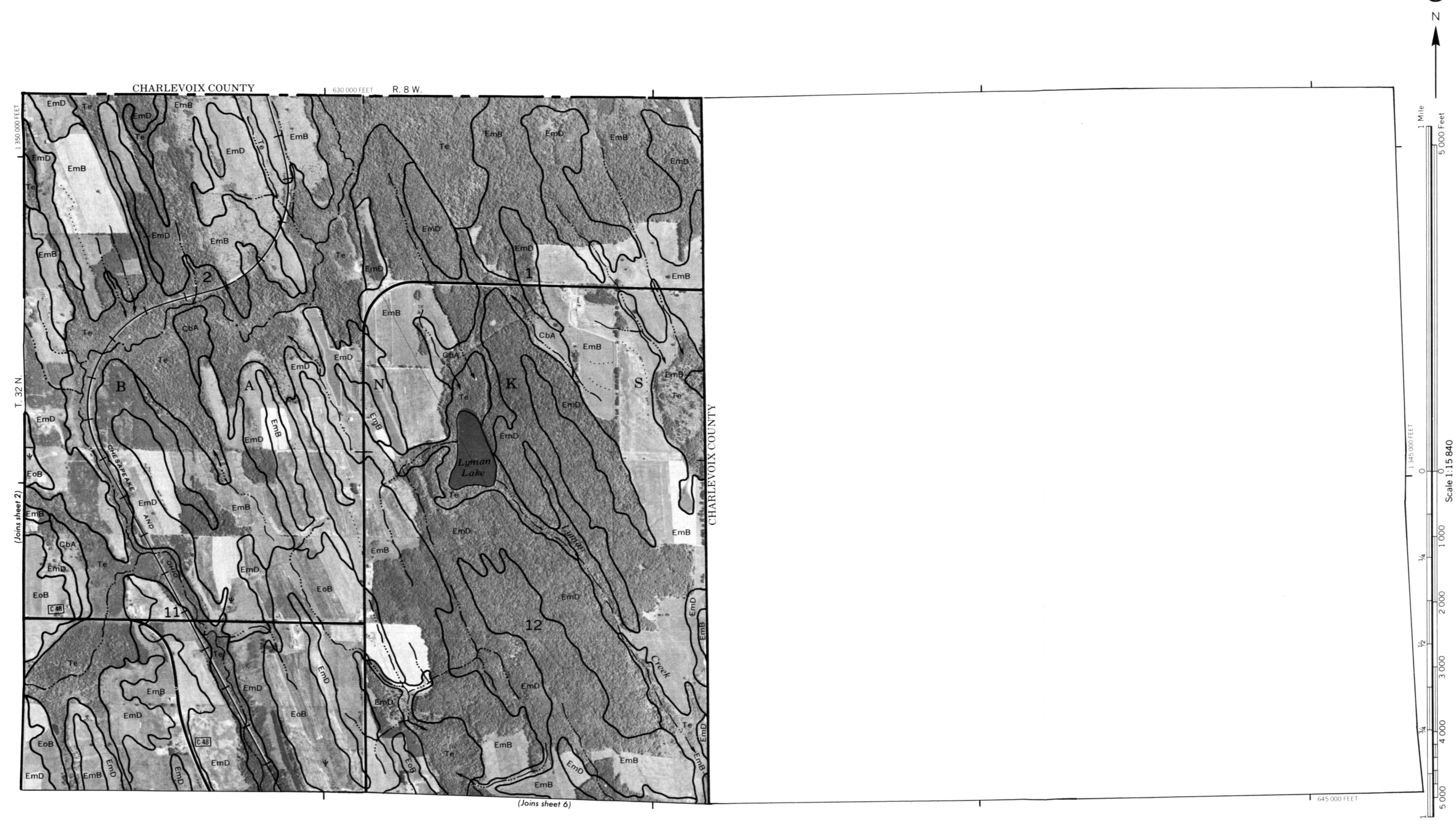
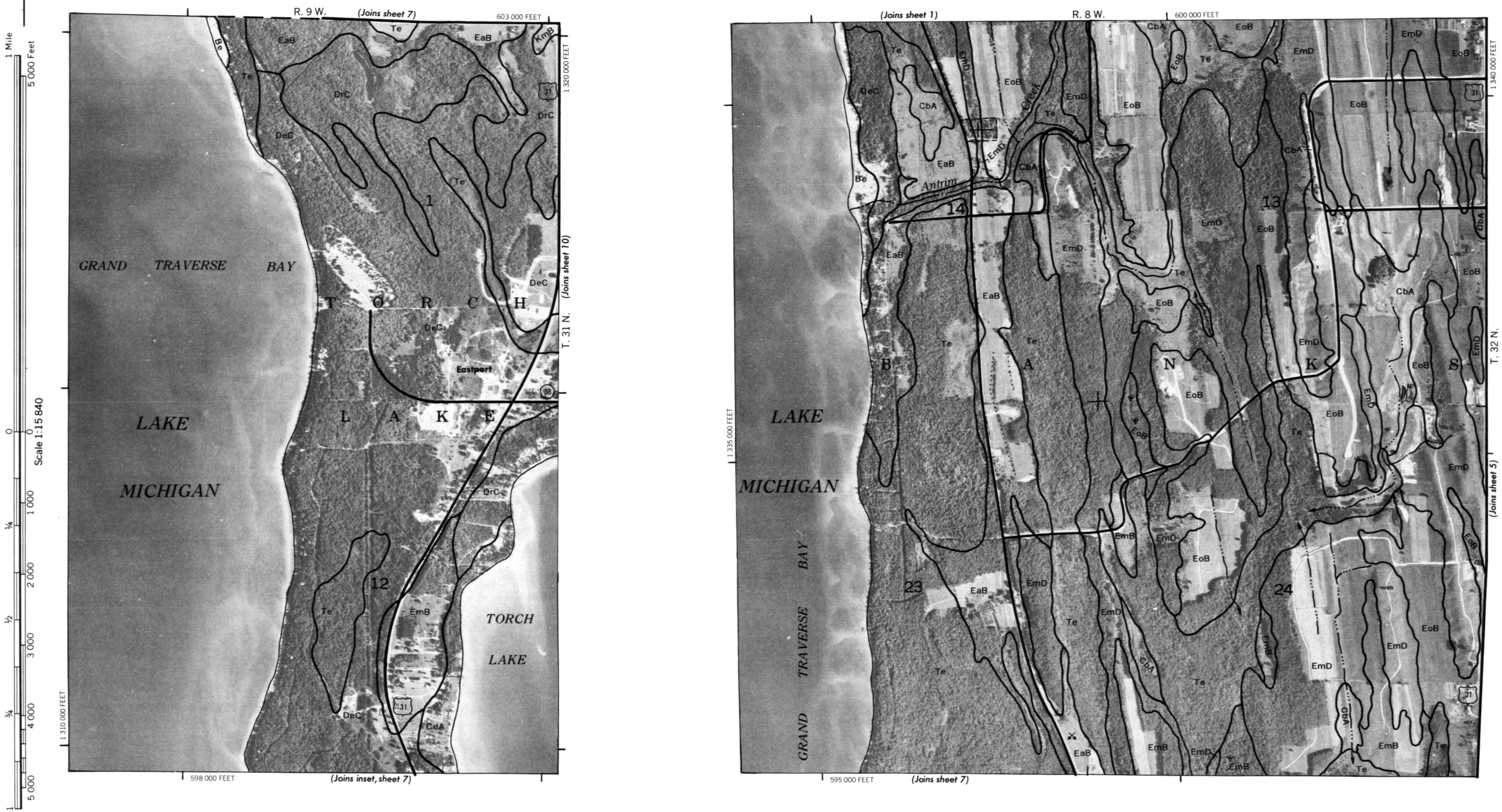
ANTRIM COUNTY, MICHIGAN NO. 2

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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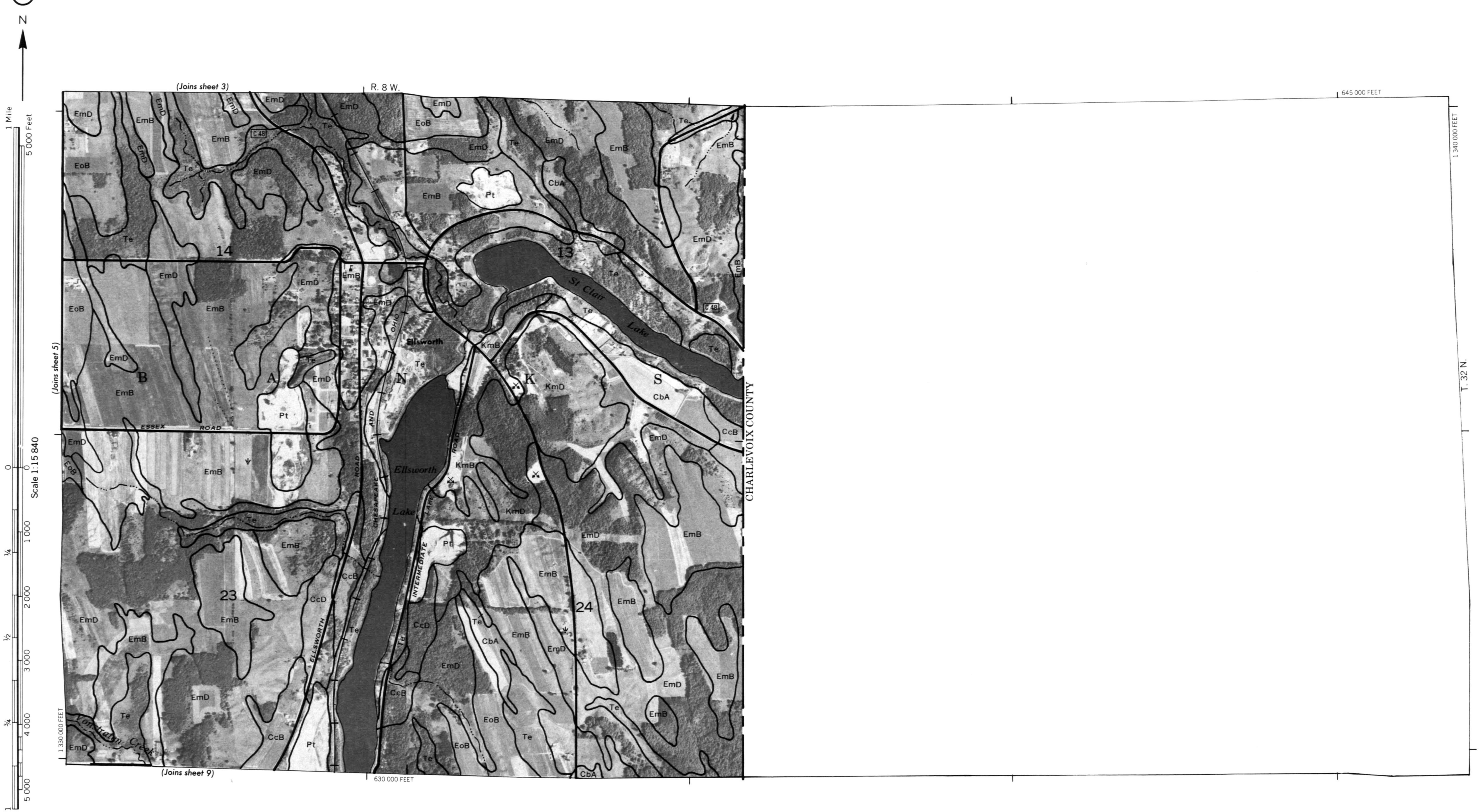
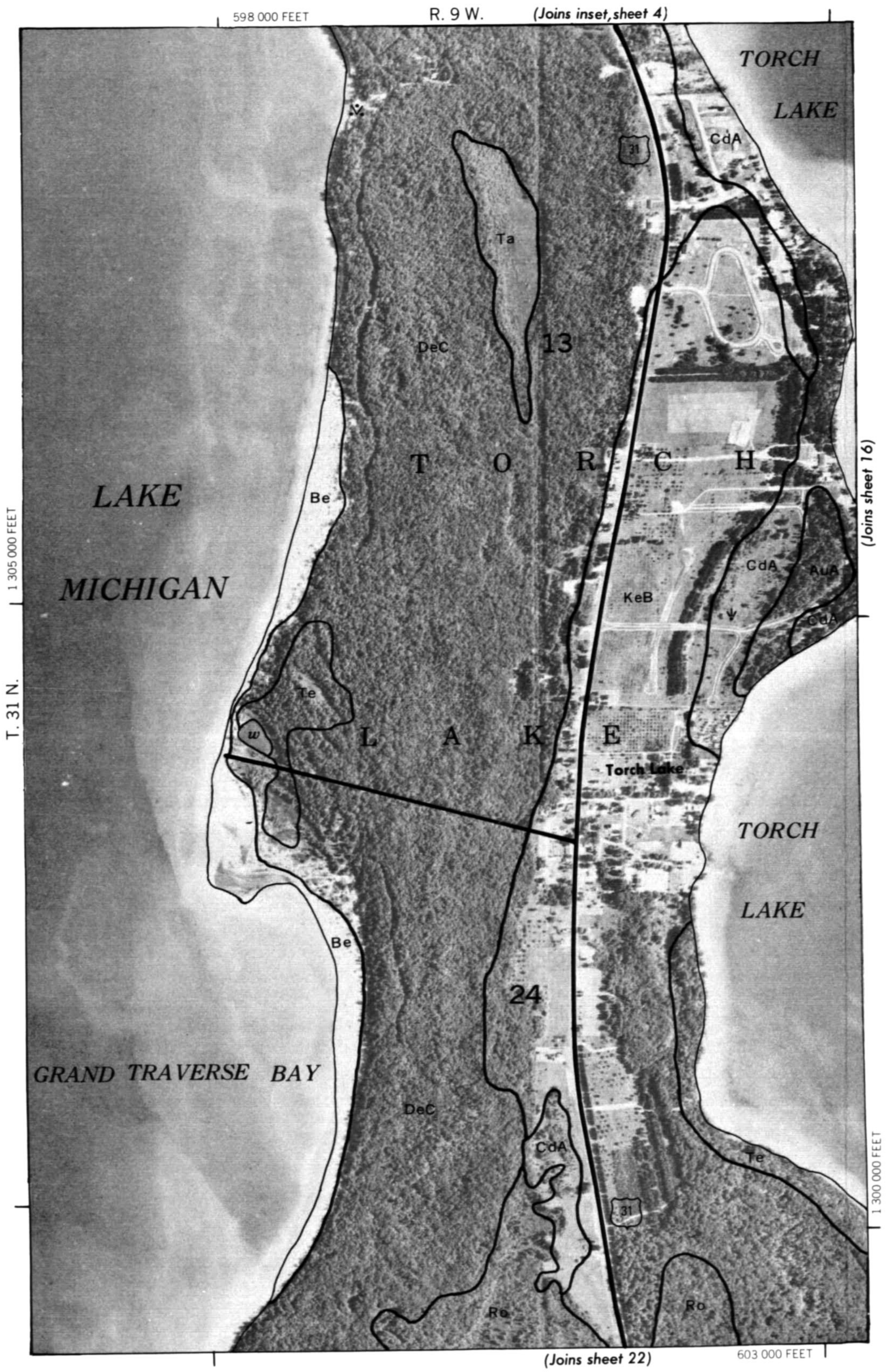
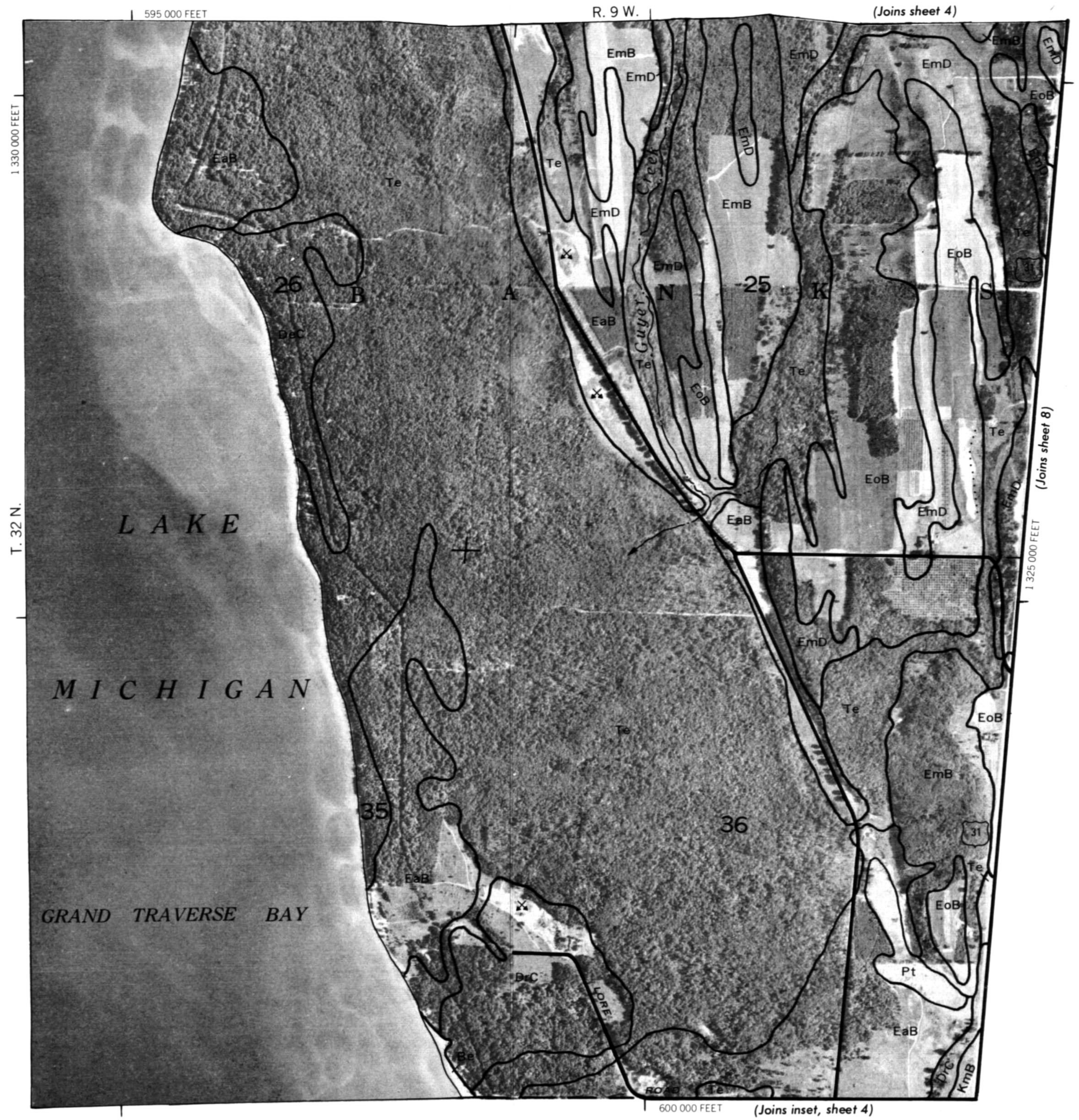
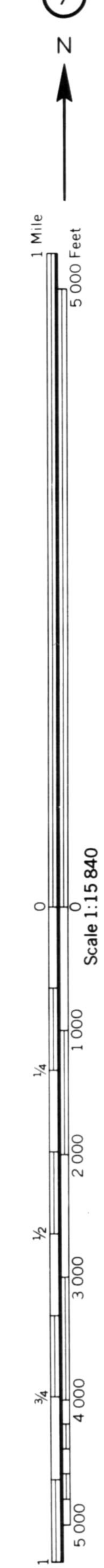


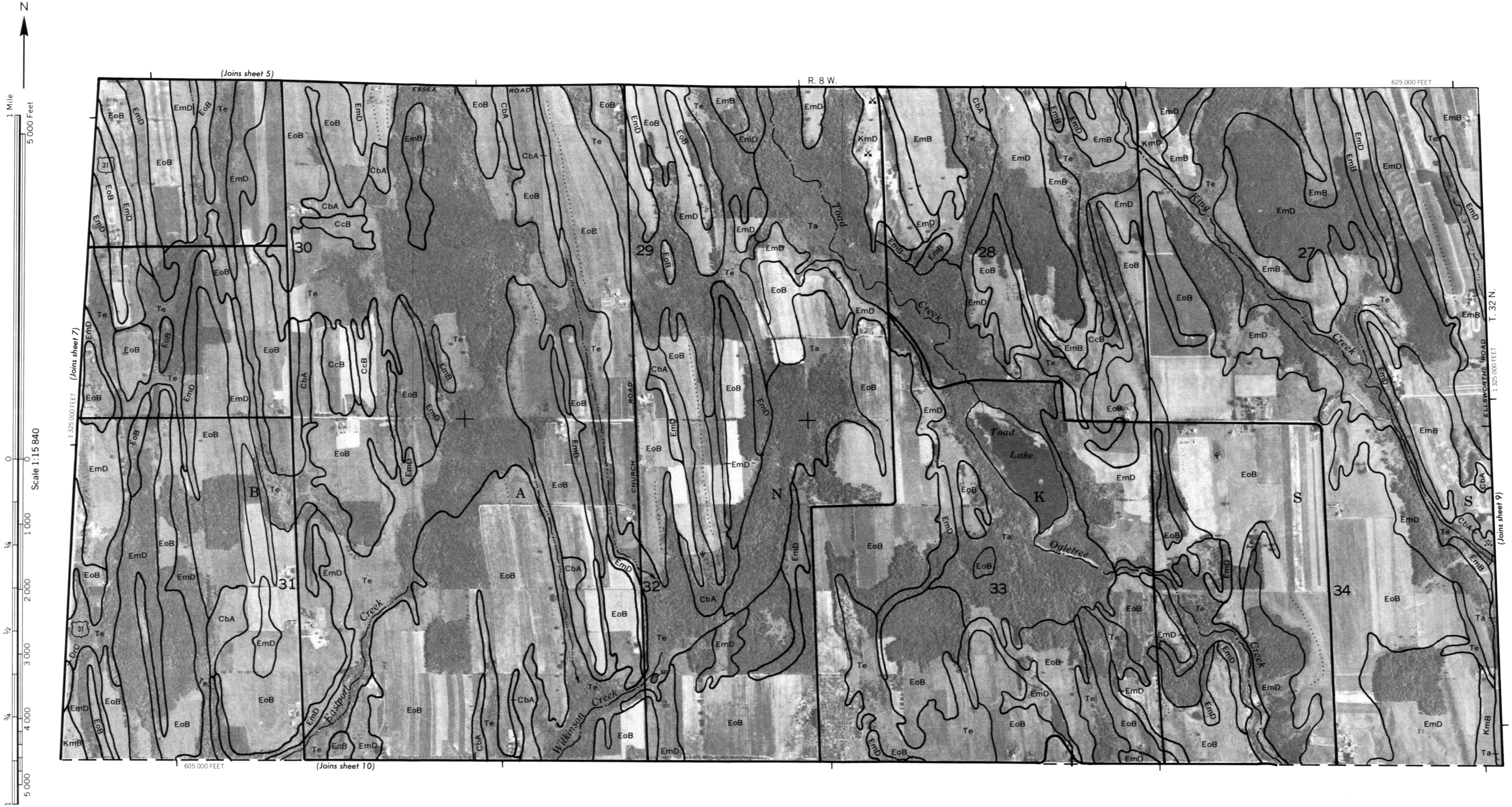
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





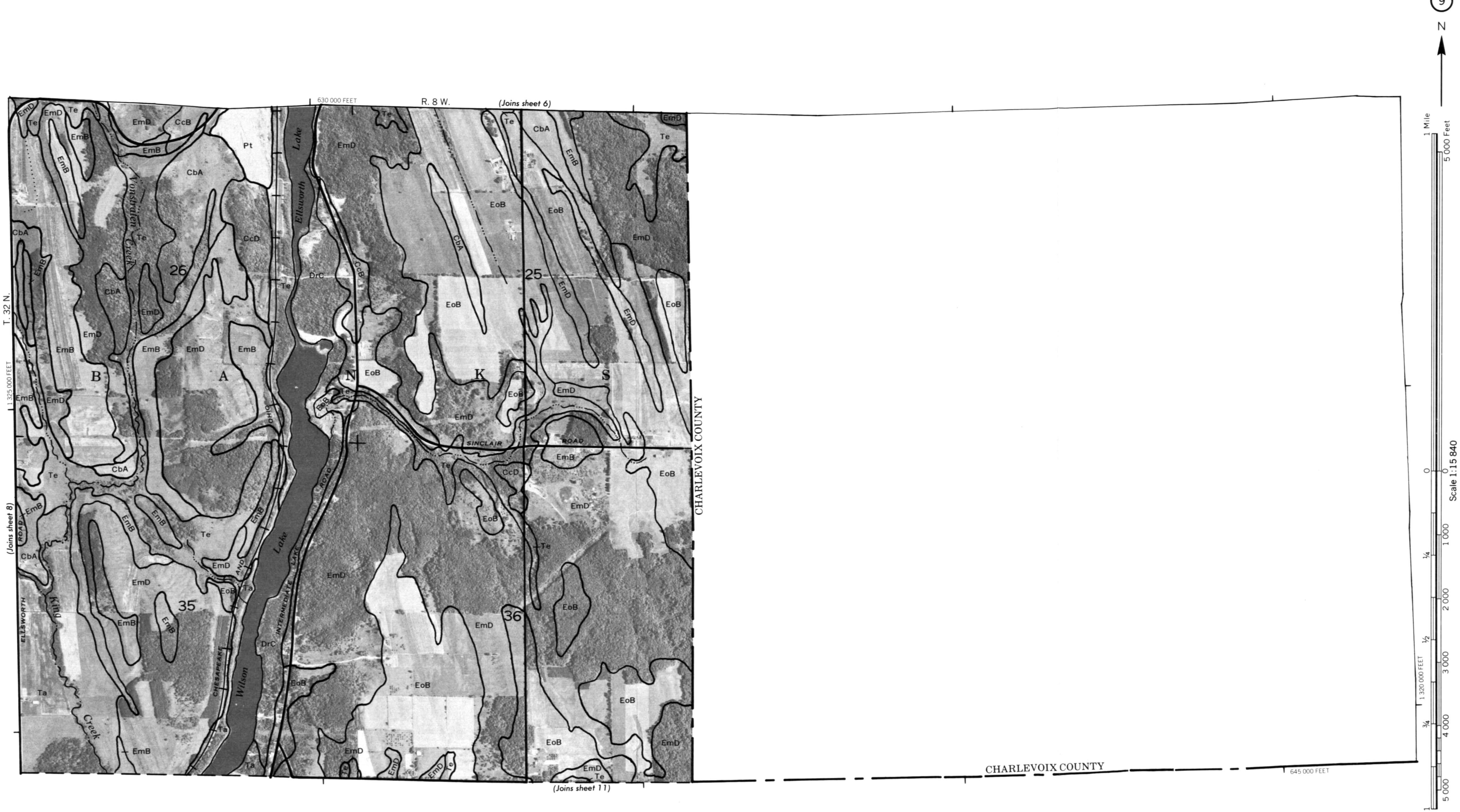


This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

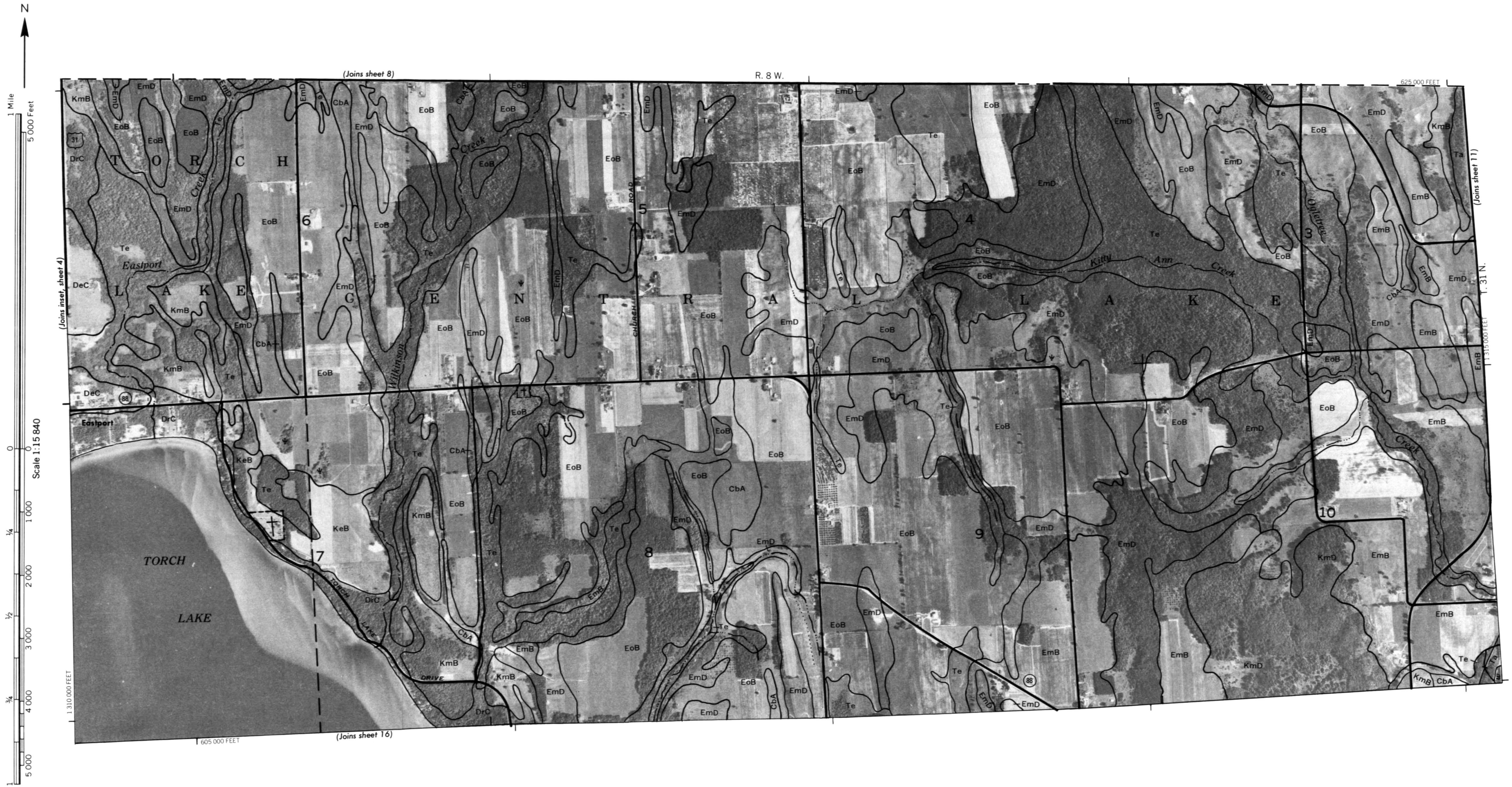


This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 8

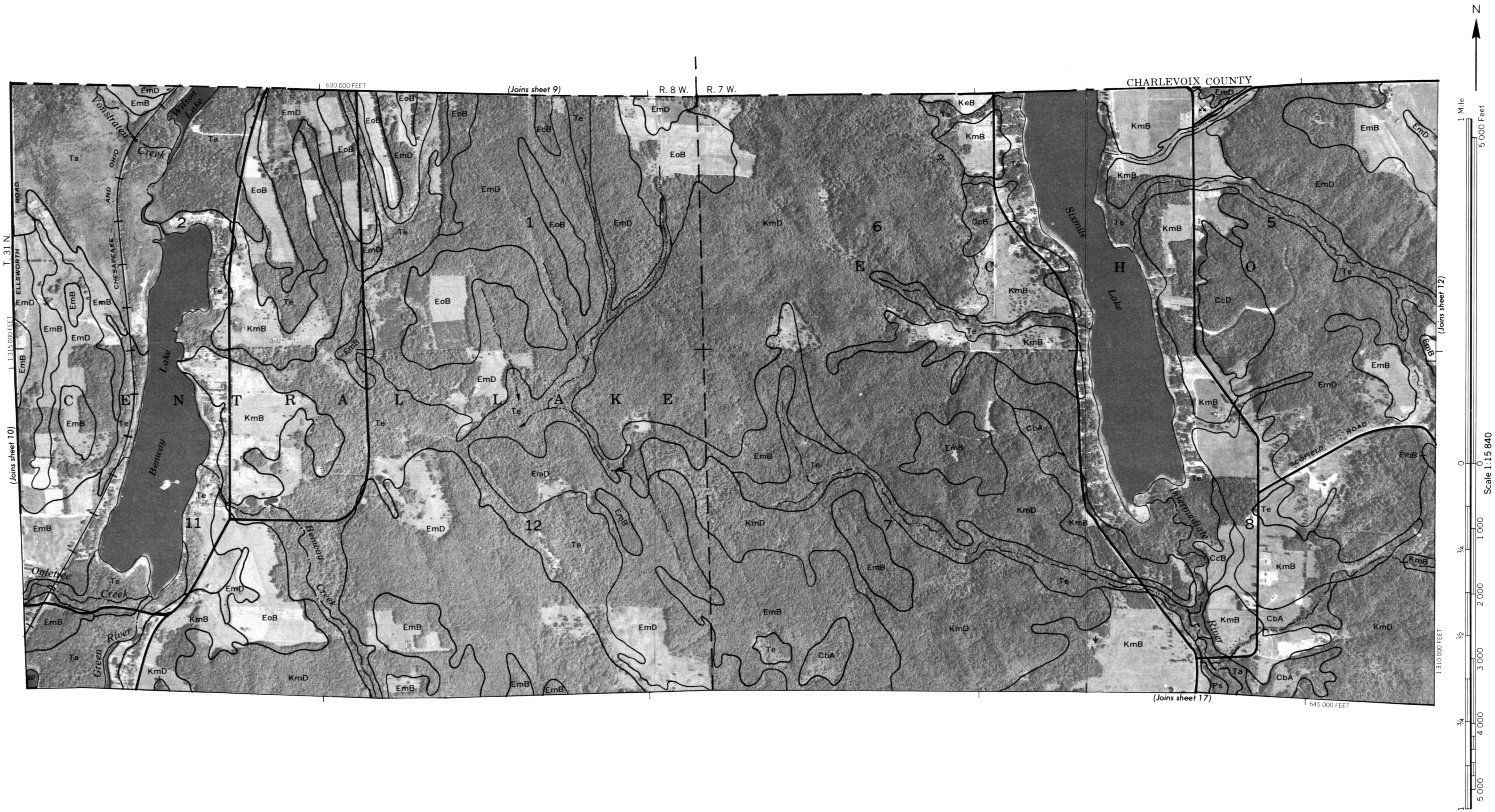


This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

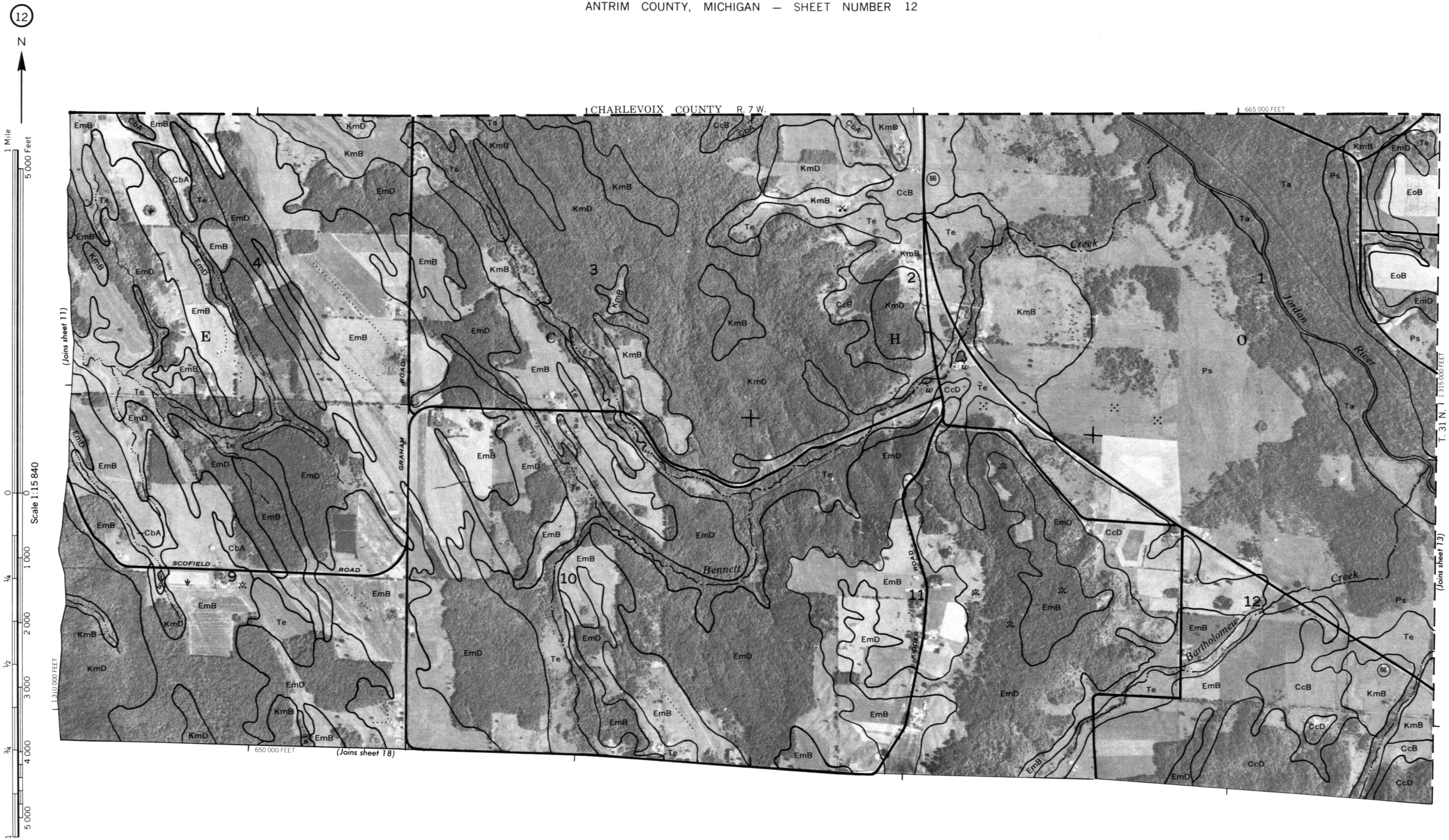


This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

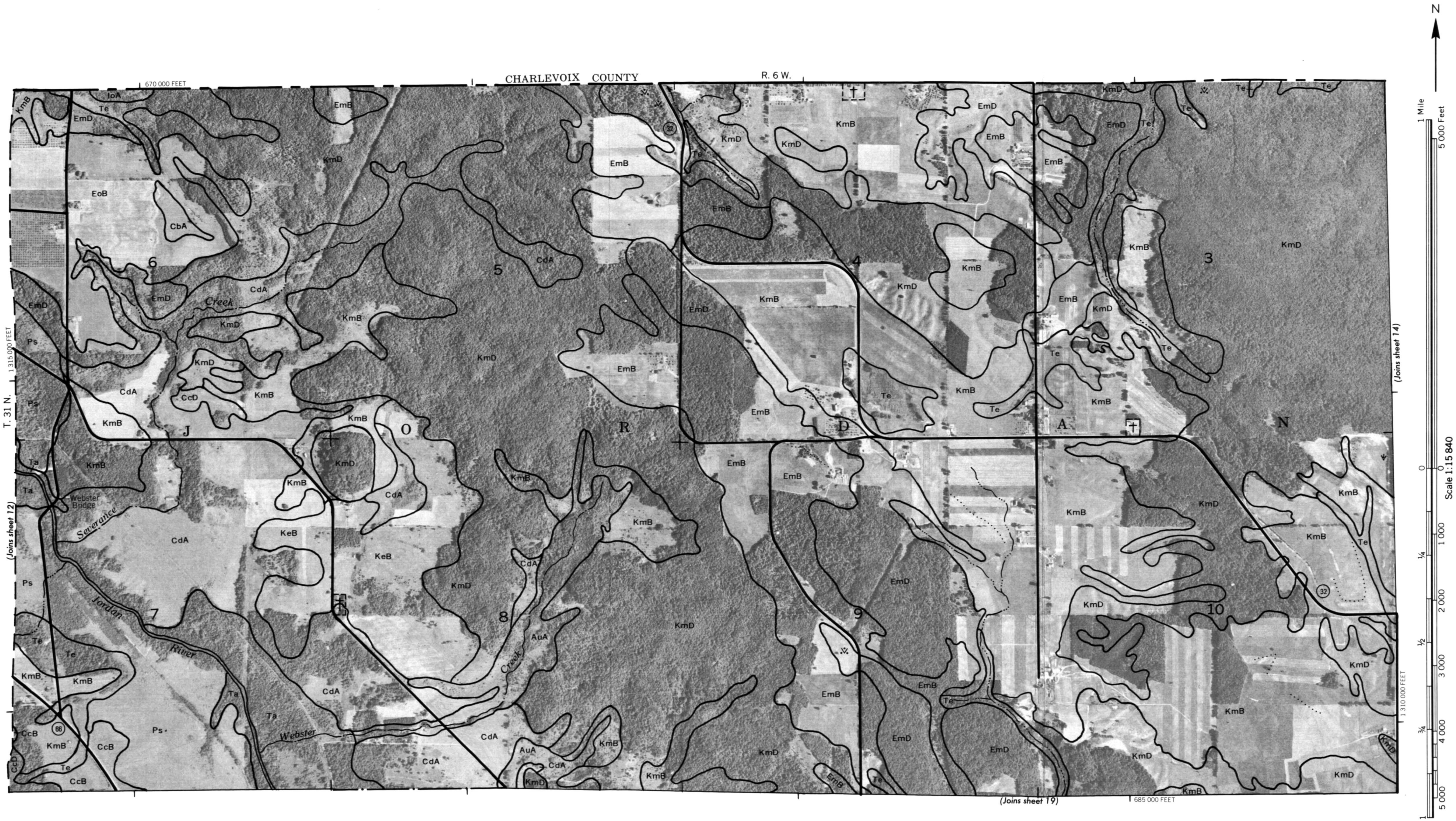
ANTRIM COUNTY, MICHIGAN NO. 10



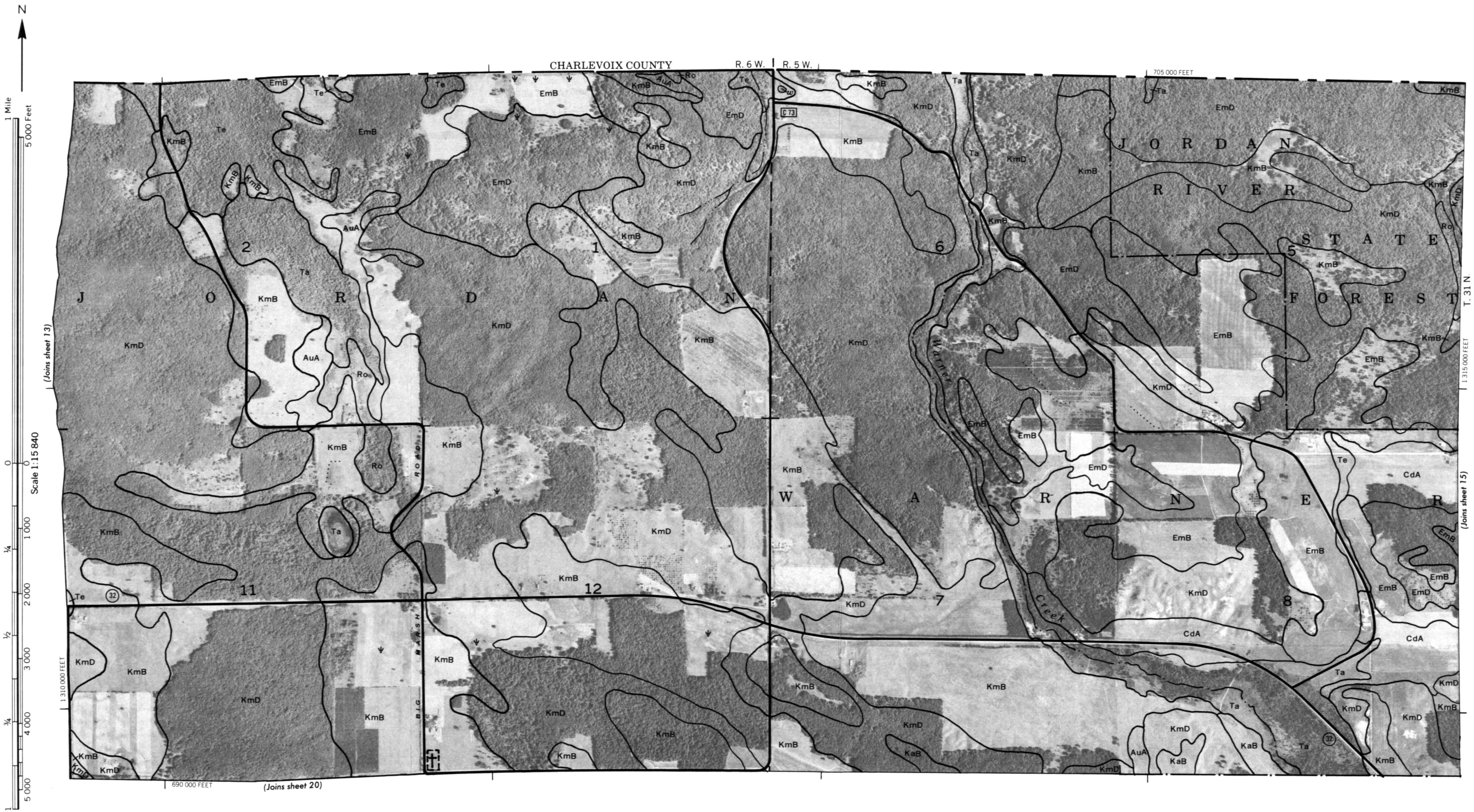
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



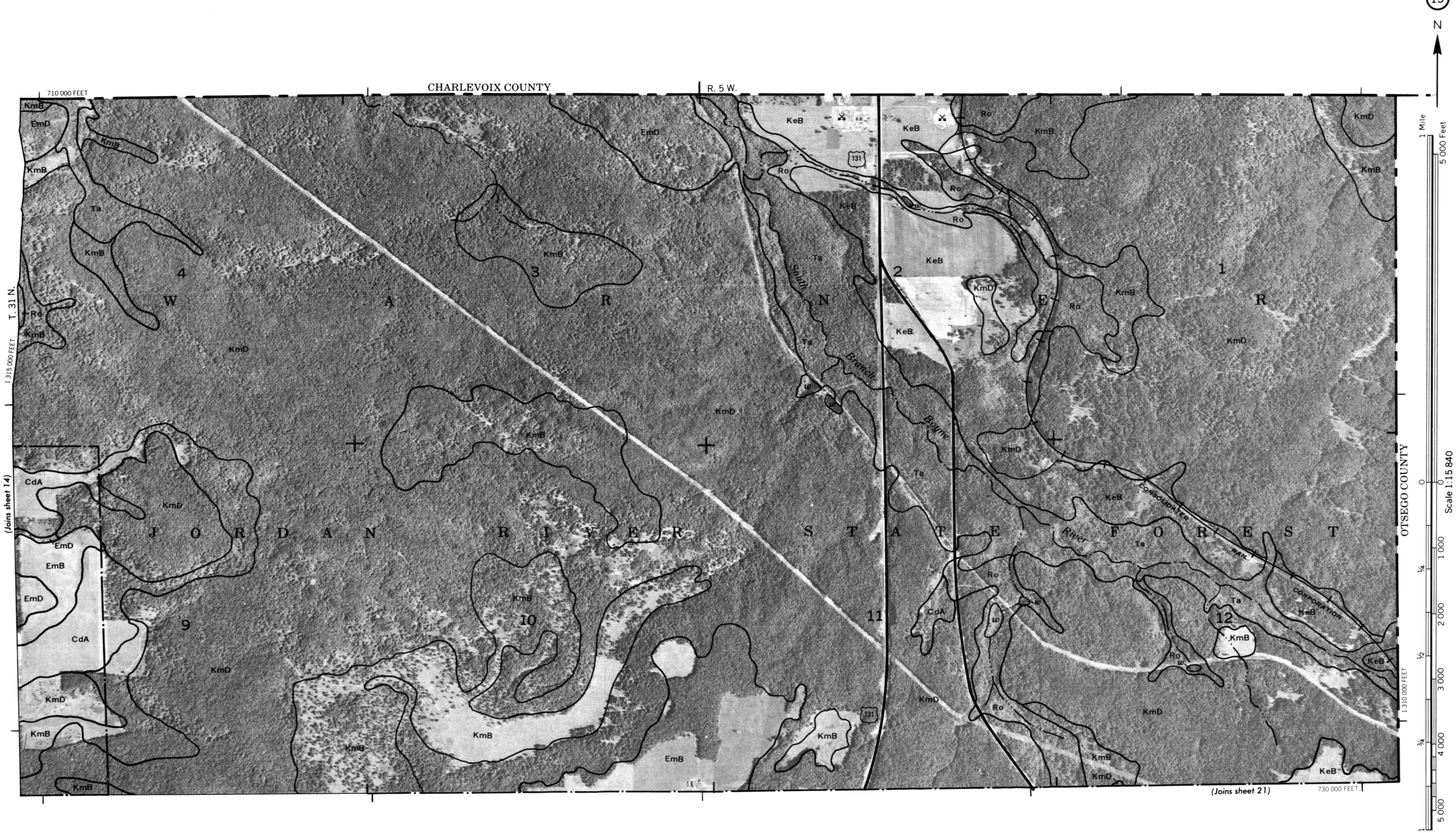
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



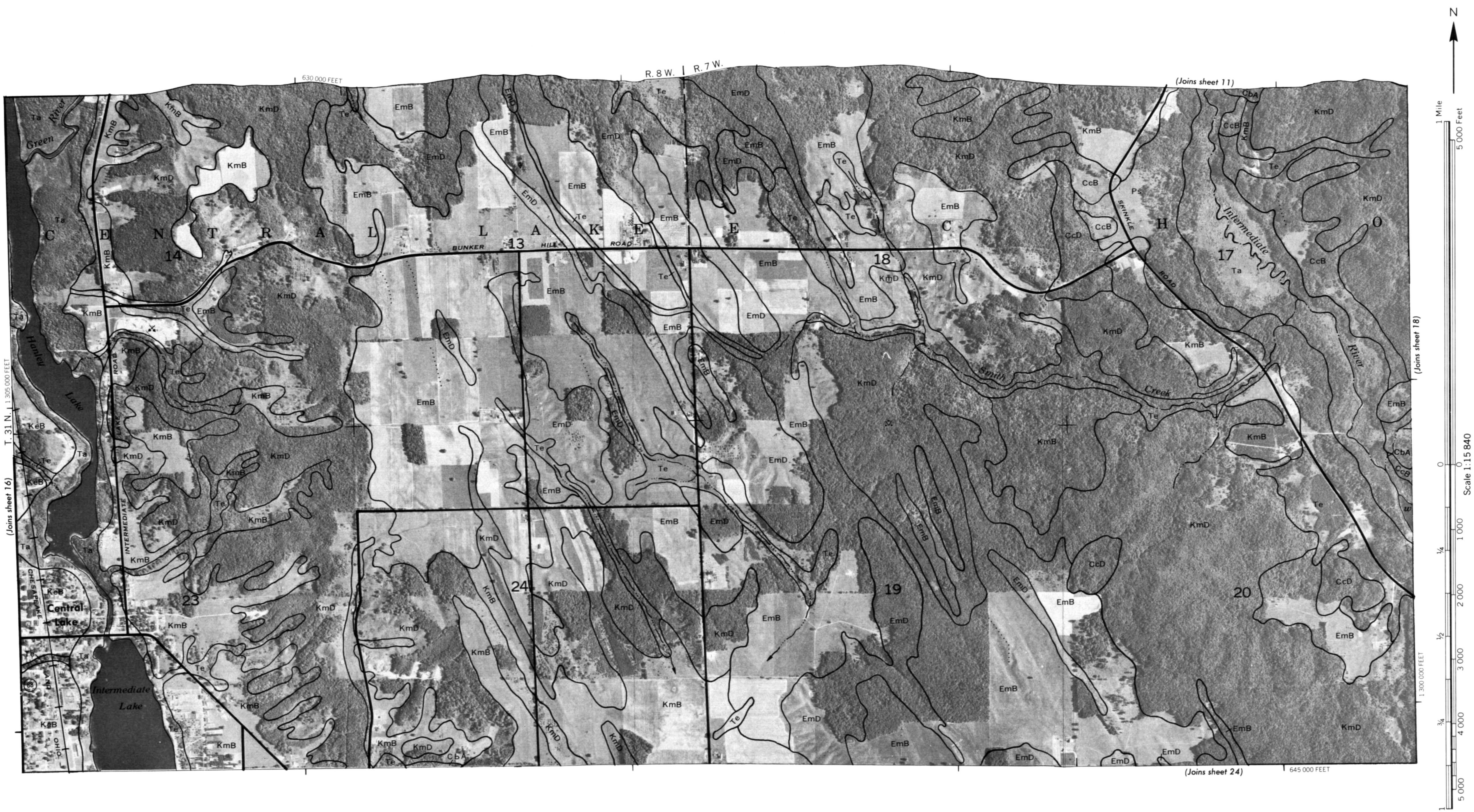
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 14

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.




N
1 Mile
5 000 Feet
0
Scale 1:15 840
1 000
¼
2 000
½
3 000
¾
4 000
5 000
1
(Joins sheet 10)
R. 8 W.
625 000 FEET
(Joins inset, sheet 7)
TORCH LAKE
T. 31 N.
1 305 000 FEET
(Joins sheet 17)
1 300 000 FEET
605 000 FEET
(Joins sheet 23)
CENTRAL LAKE
TORCH LAKE
OLD STATE ROAD
CHESAPEAKE AND OHIO
Central Lake
593
624
88
17
16
15
20
21
22
DrC
KmB
EoB
EmD
Te
EmB
CbA
EoB
EmB
KmD
CdA
KeB
CcD
KeB

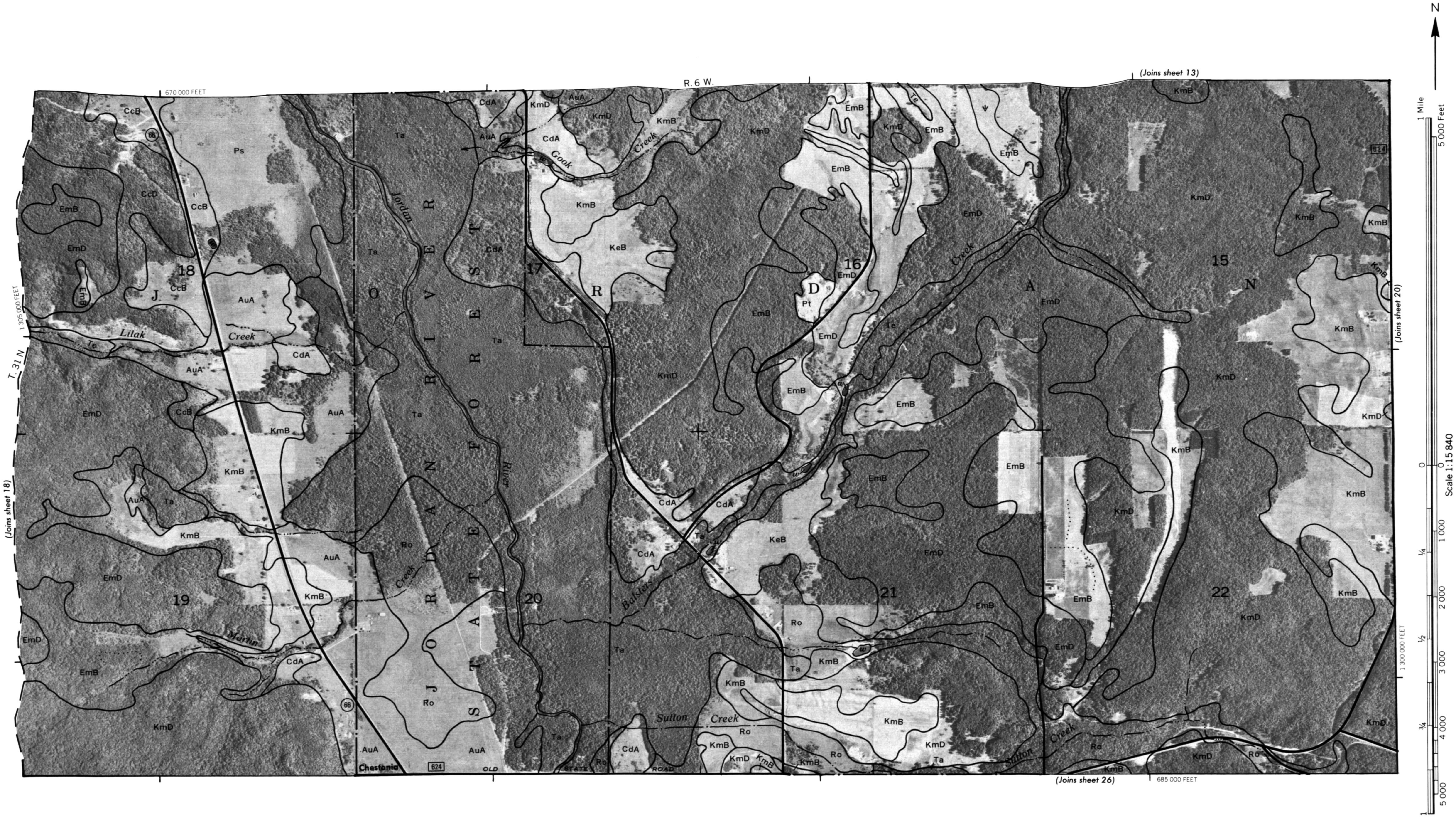


This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 18

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 20

N

1 Mile

5 000 Feet

0

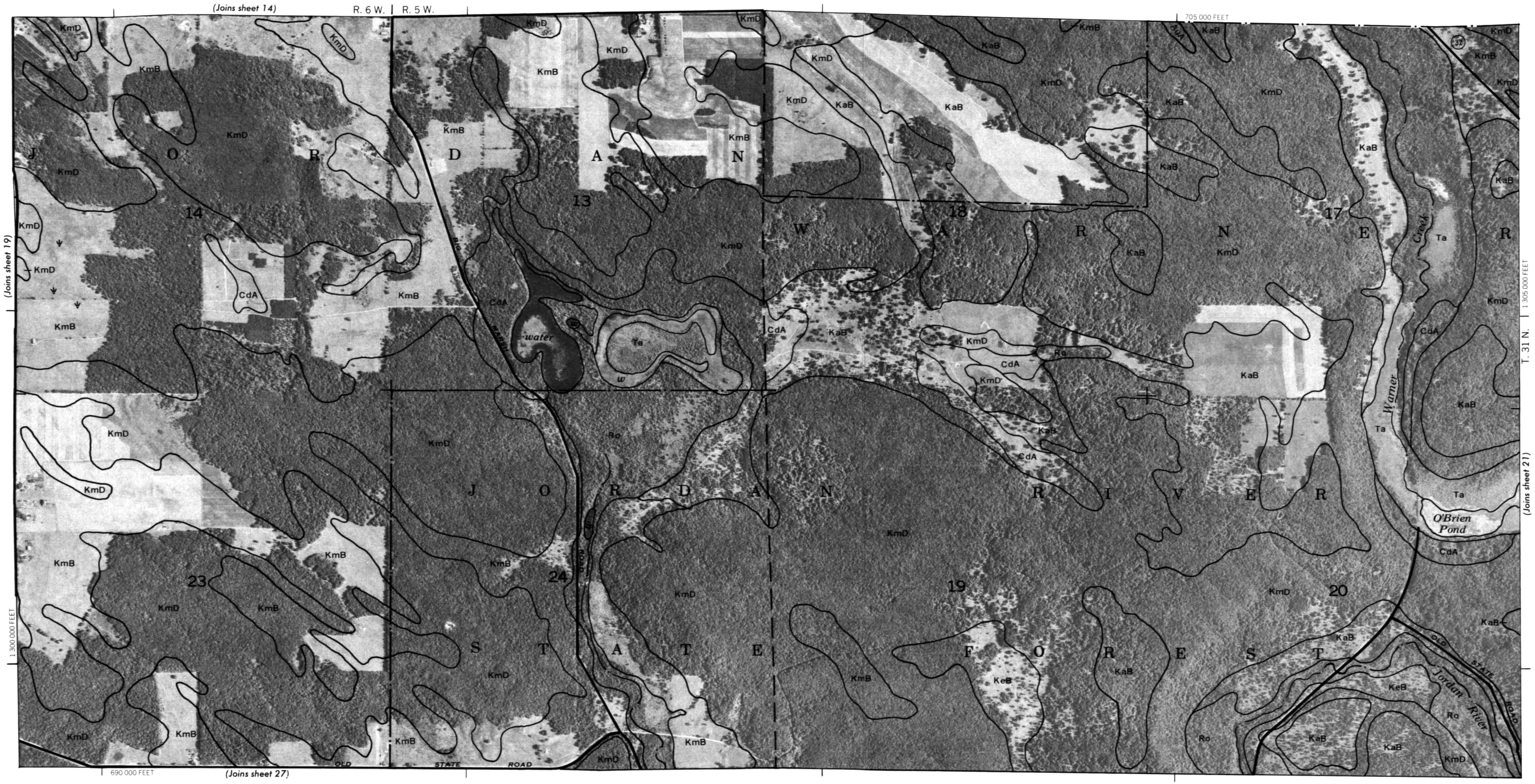
Scale 1:15 840

¼ 1 000 2 000

½ 3 000

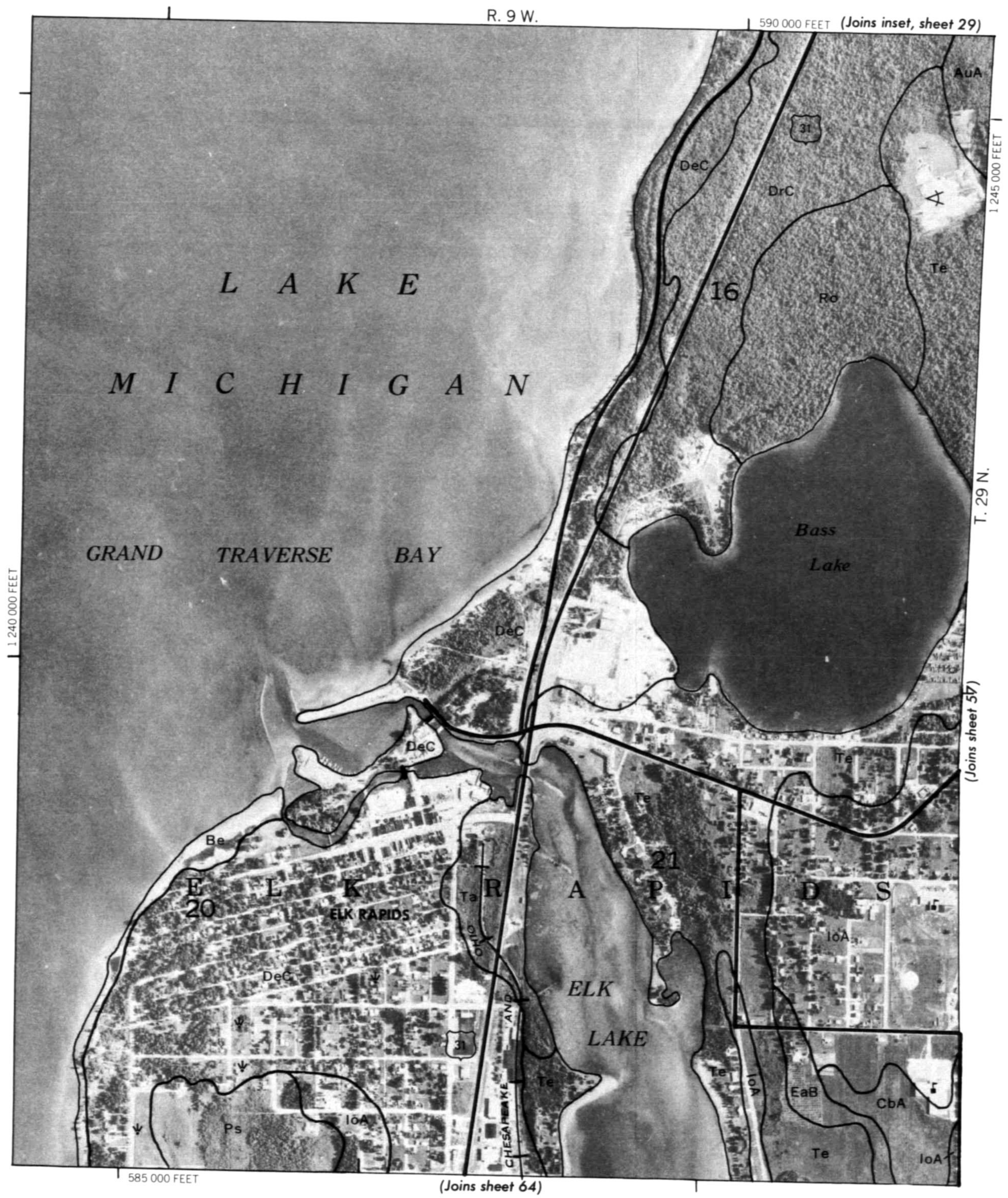
¾ 4 000

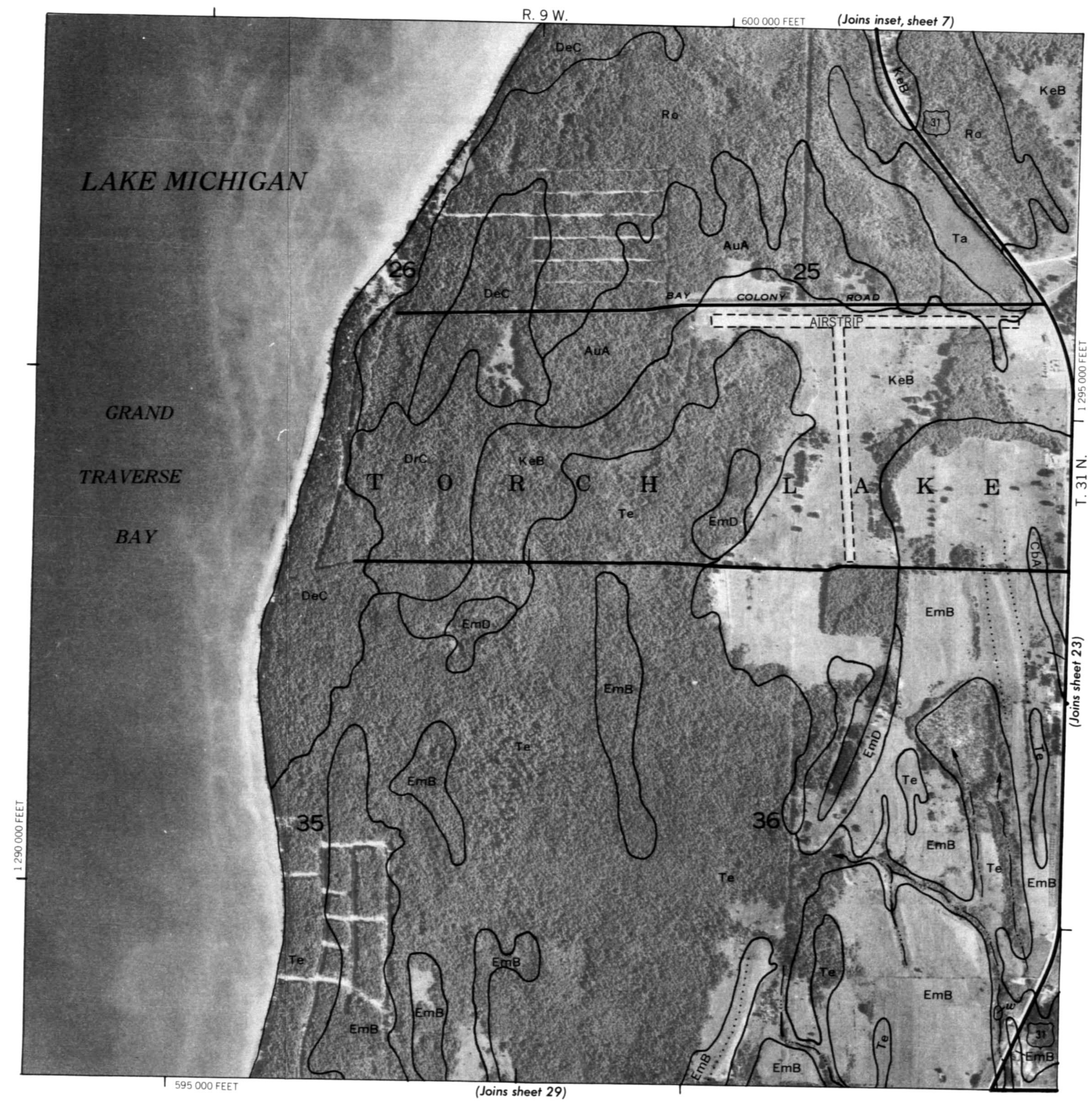
1 5 000



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.





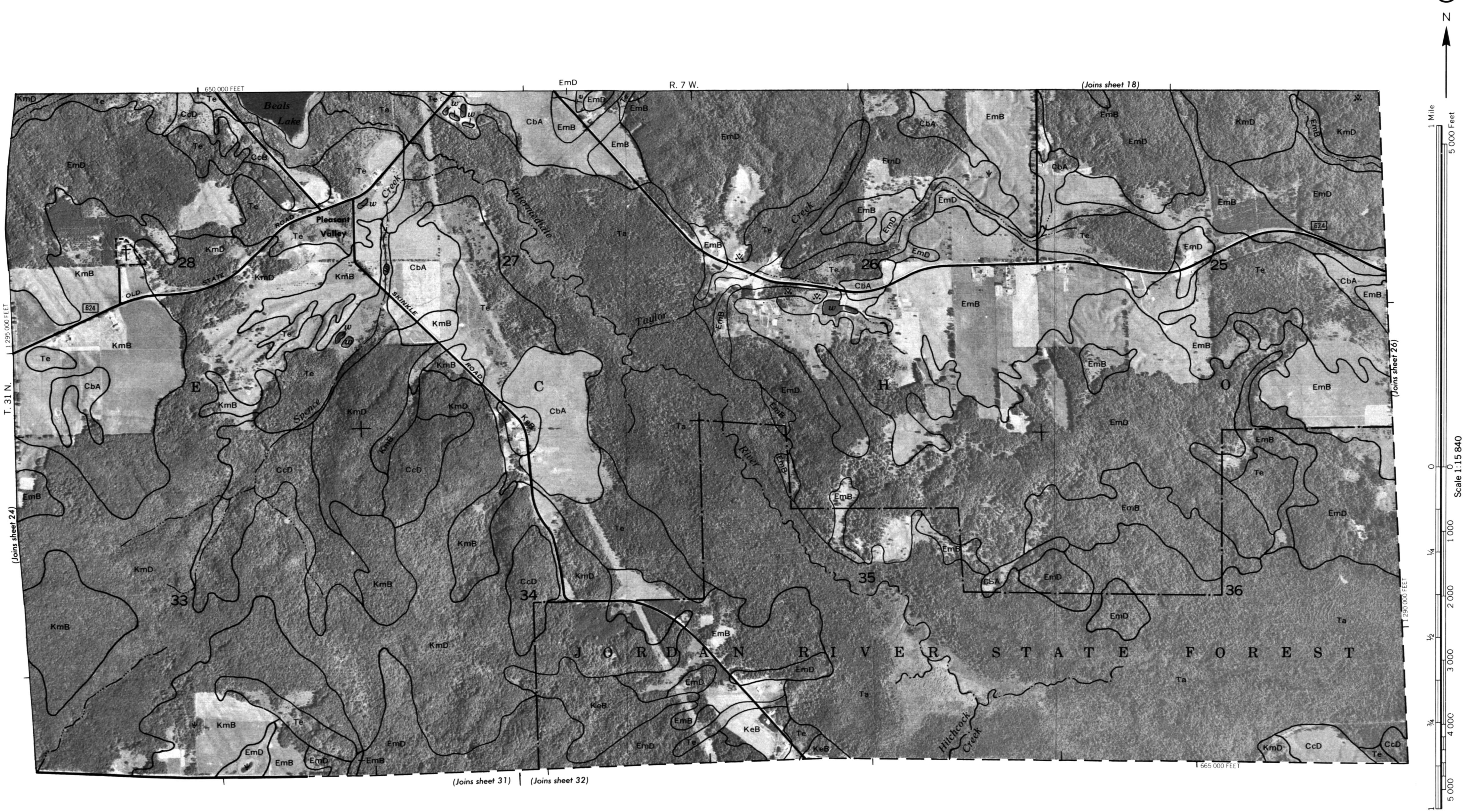
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 22

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

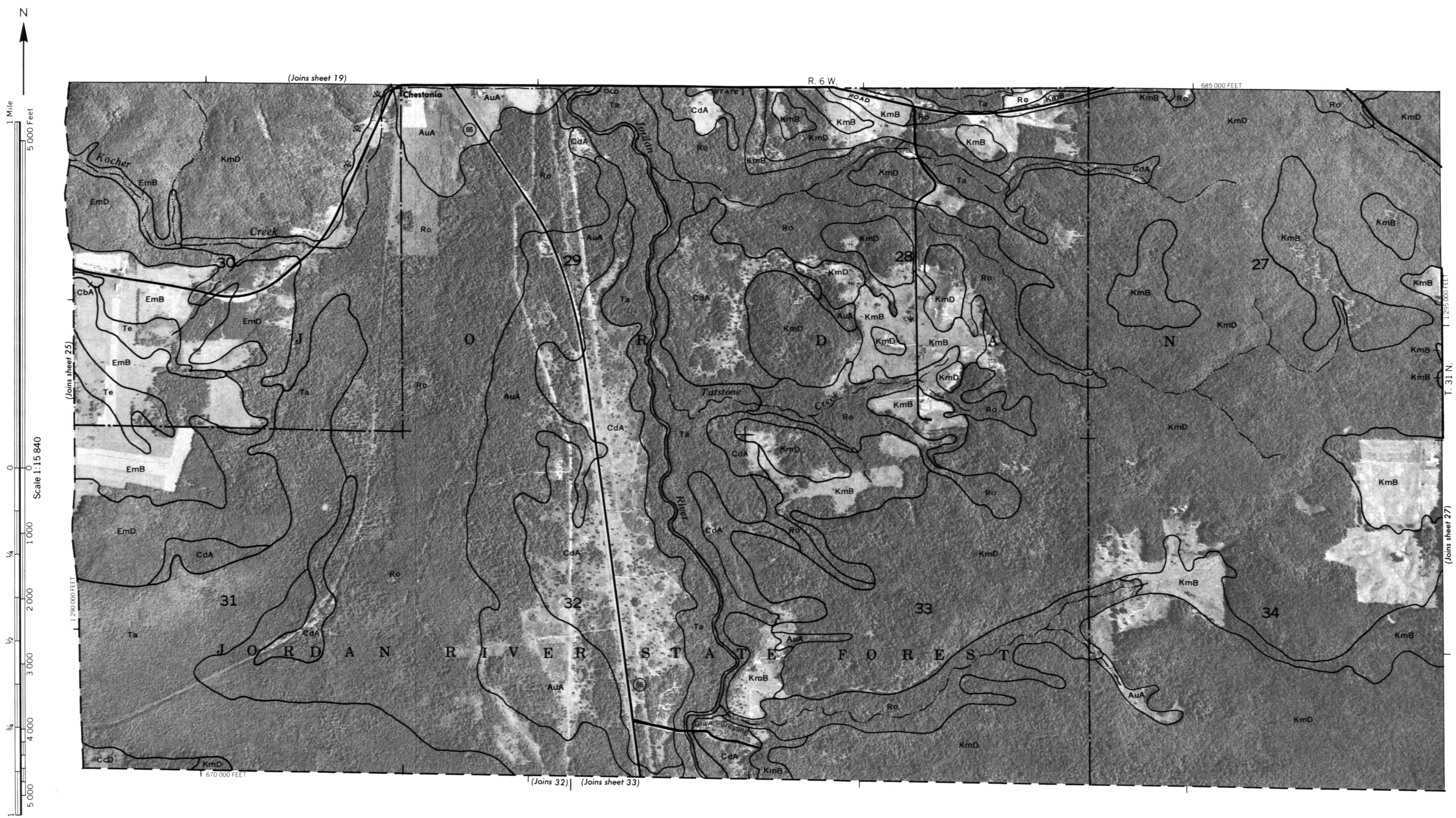
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 24



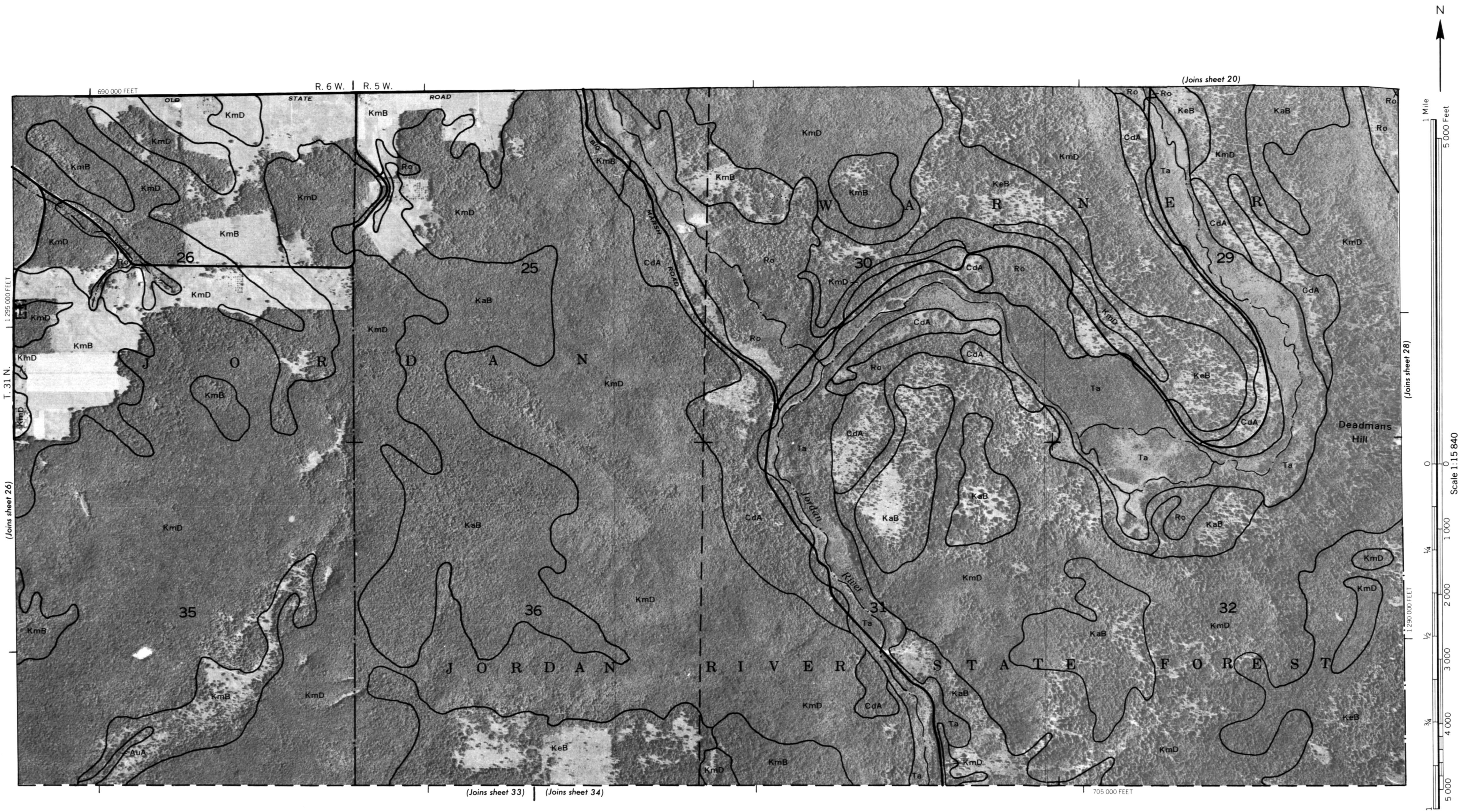
ANTRIM COUNTY, MICHIGAN NO. 25

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 26

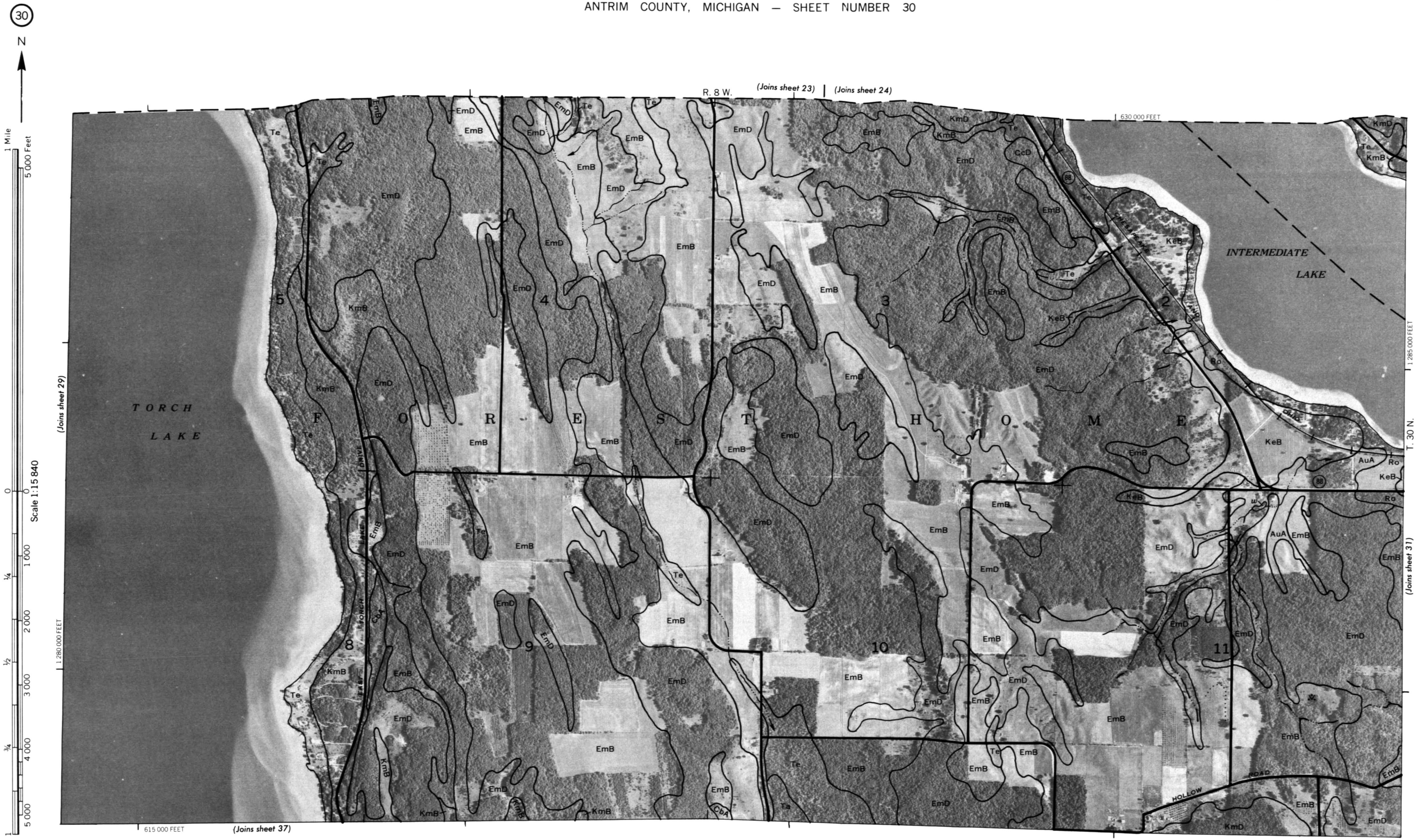


ANTRIM COUNTY, MICHIGAN NO. 27

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


29
N
(Joins sheet 22)
(Joins sheet 23)
R. 9 W.
R. 8 W.
595 000 FEET
590 000 FEET
592 000 FEET
610 000 FEET
1 285 000 FEET
1 280 000 FEET
1 253 000 FEET
1 248 000 FEET
T. 30 N.
T. 29 N.
LAKE MICHIGAN
GRAND TRAVERSE BAY
ELK RAPIDS
(Joins sheet 50)
(Joins inset, sheet 22)
2000 AND 5000-FOOT GRID TICKS
TORCH LAKE
Creswell
SCHOOL
CRESWELL ROAD
(Joins sheet 30)
(Joins sheet 36)
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
1 Mile
5 000 Feet
Scale 1:15 840



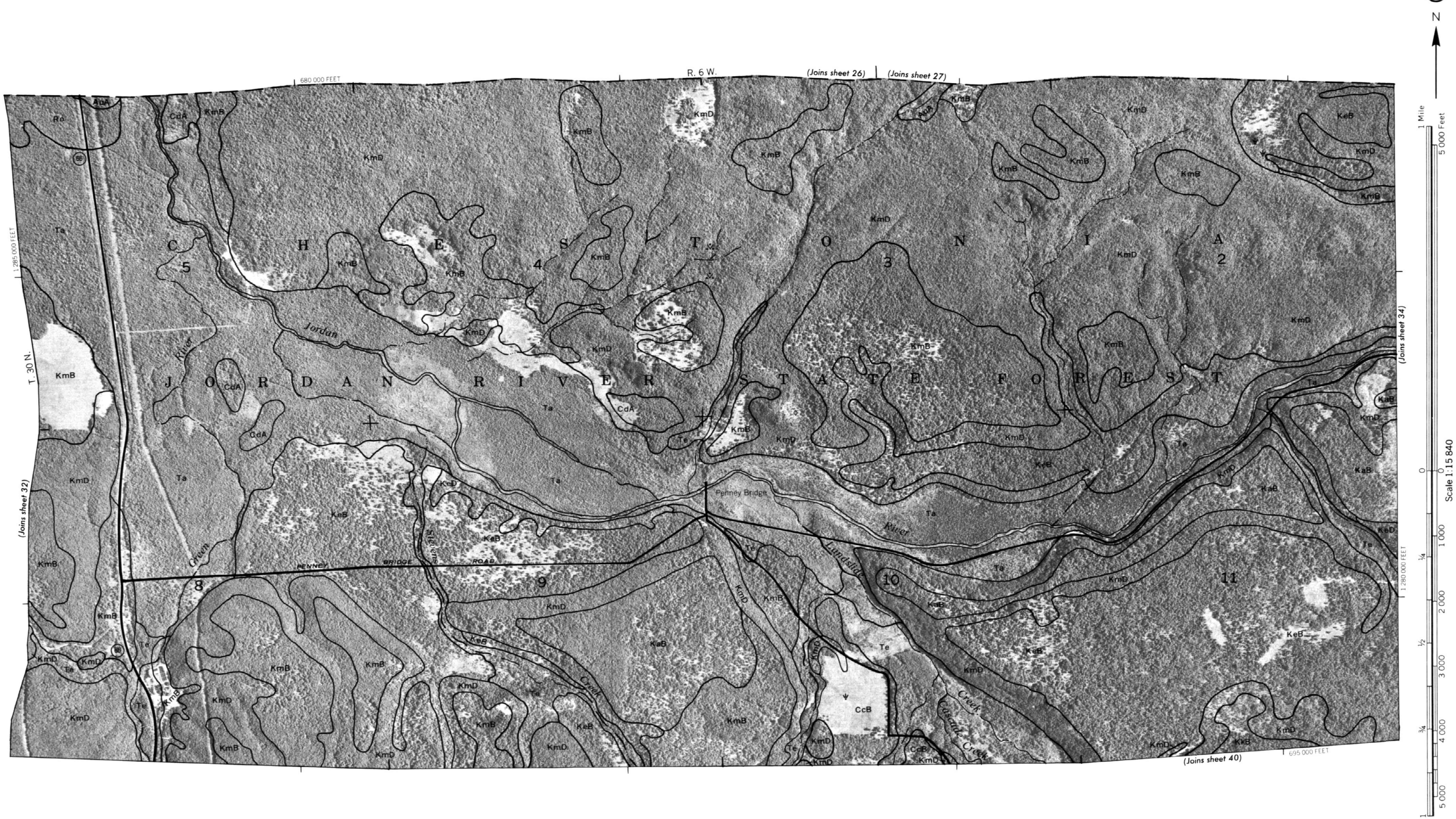
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 30

ANTRIM COUNTY, MICHIGAN NO. 31

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

Scale 1:15 840

1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 35

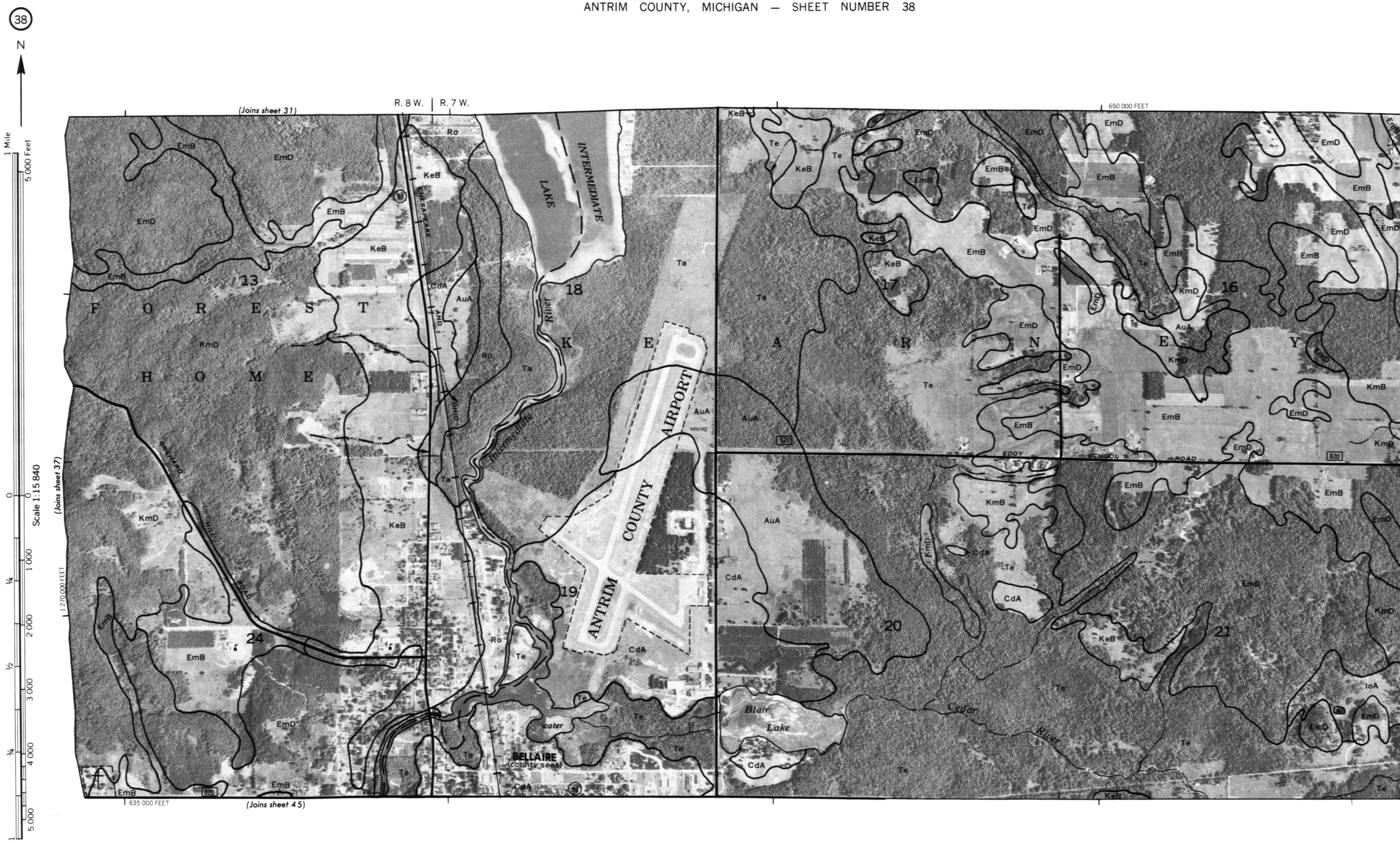
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 36

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 36

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

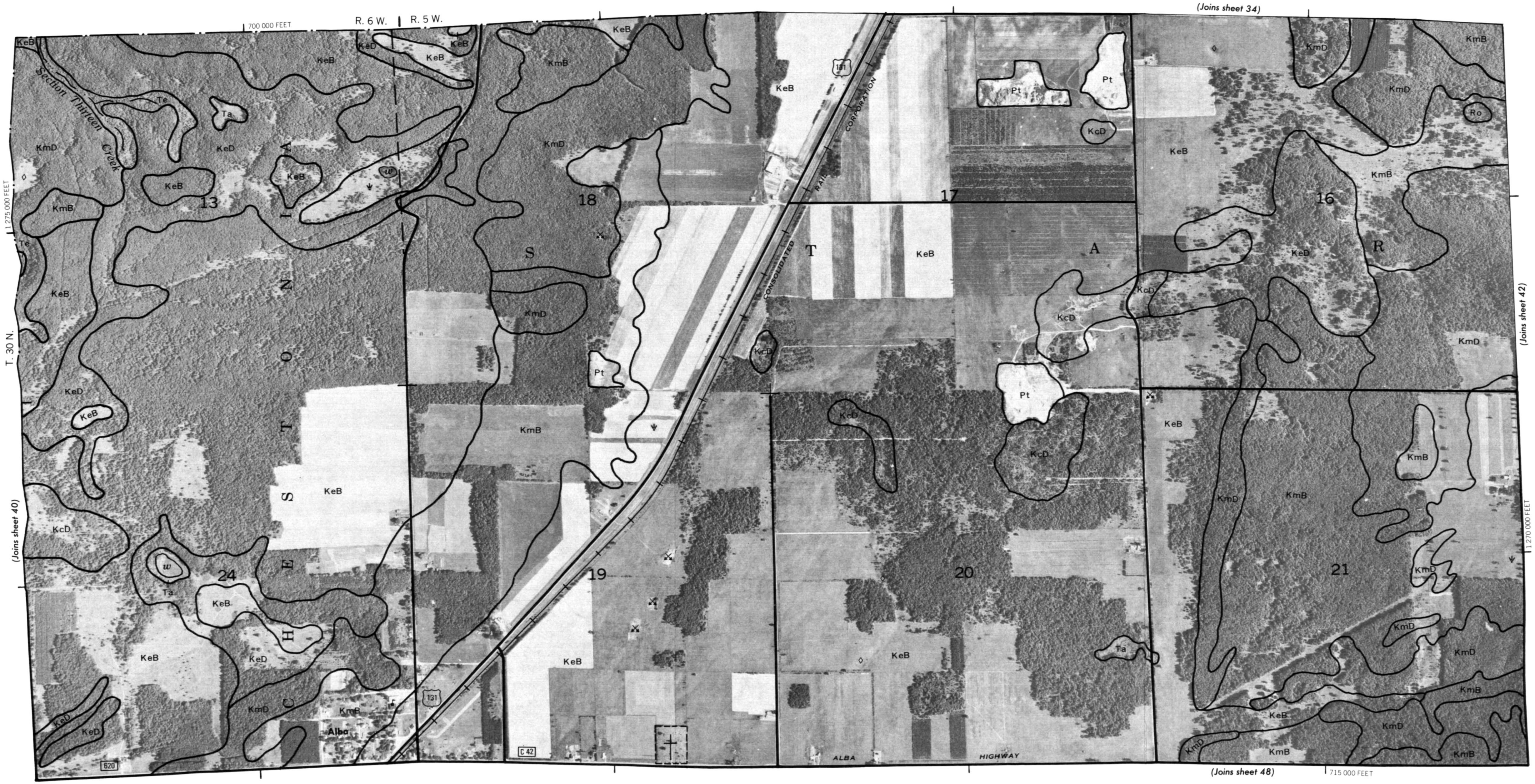
ANTRIM COUNTY, MICHIGAN NO. 38

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 Mile
5 000 Feet
Scale 1:15 840
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 42

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 42

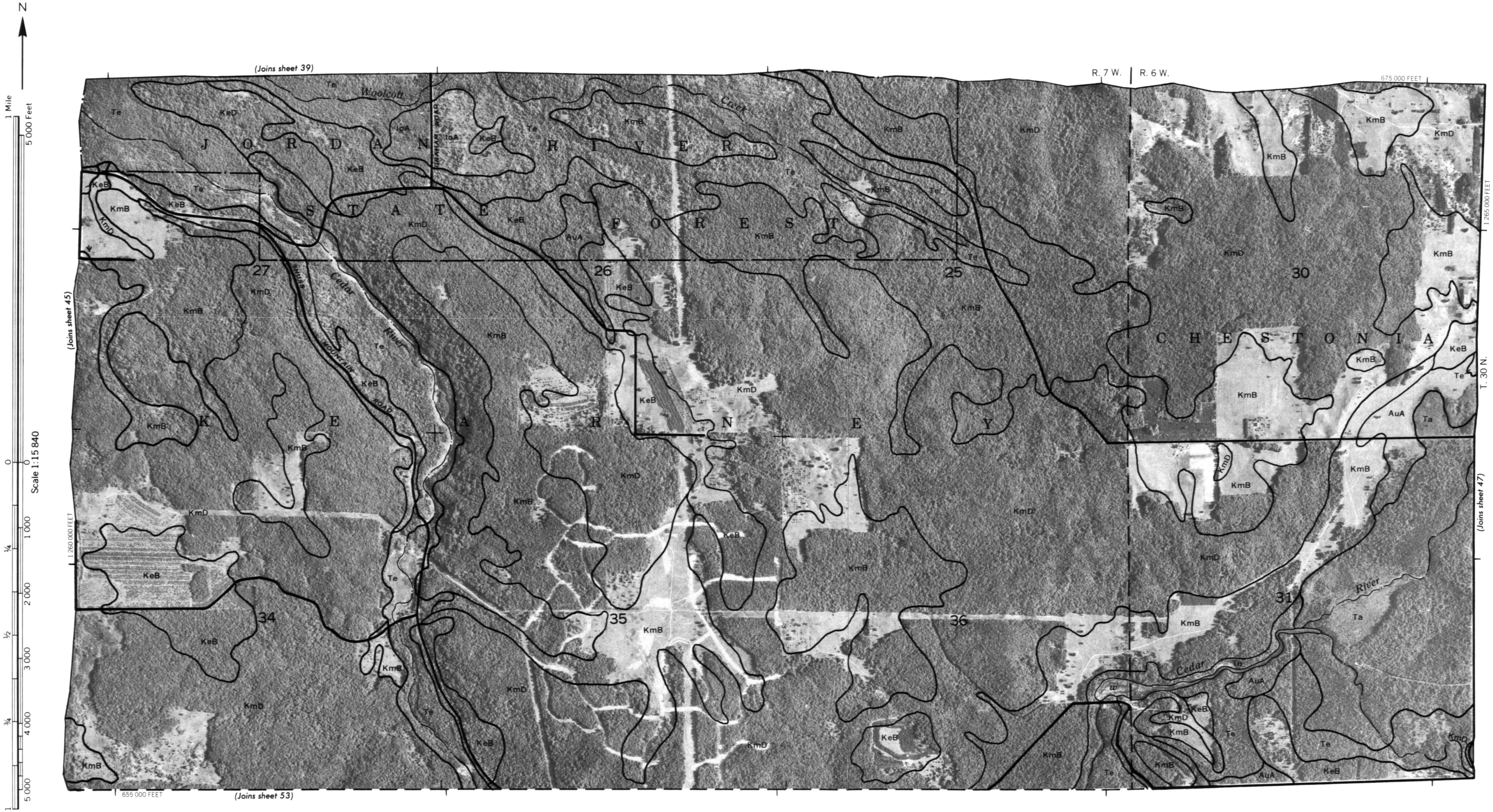
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 44

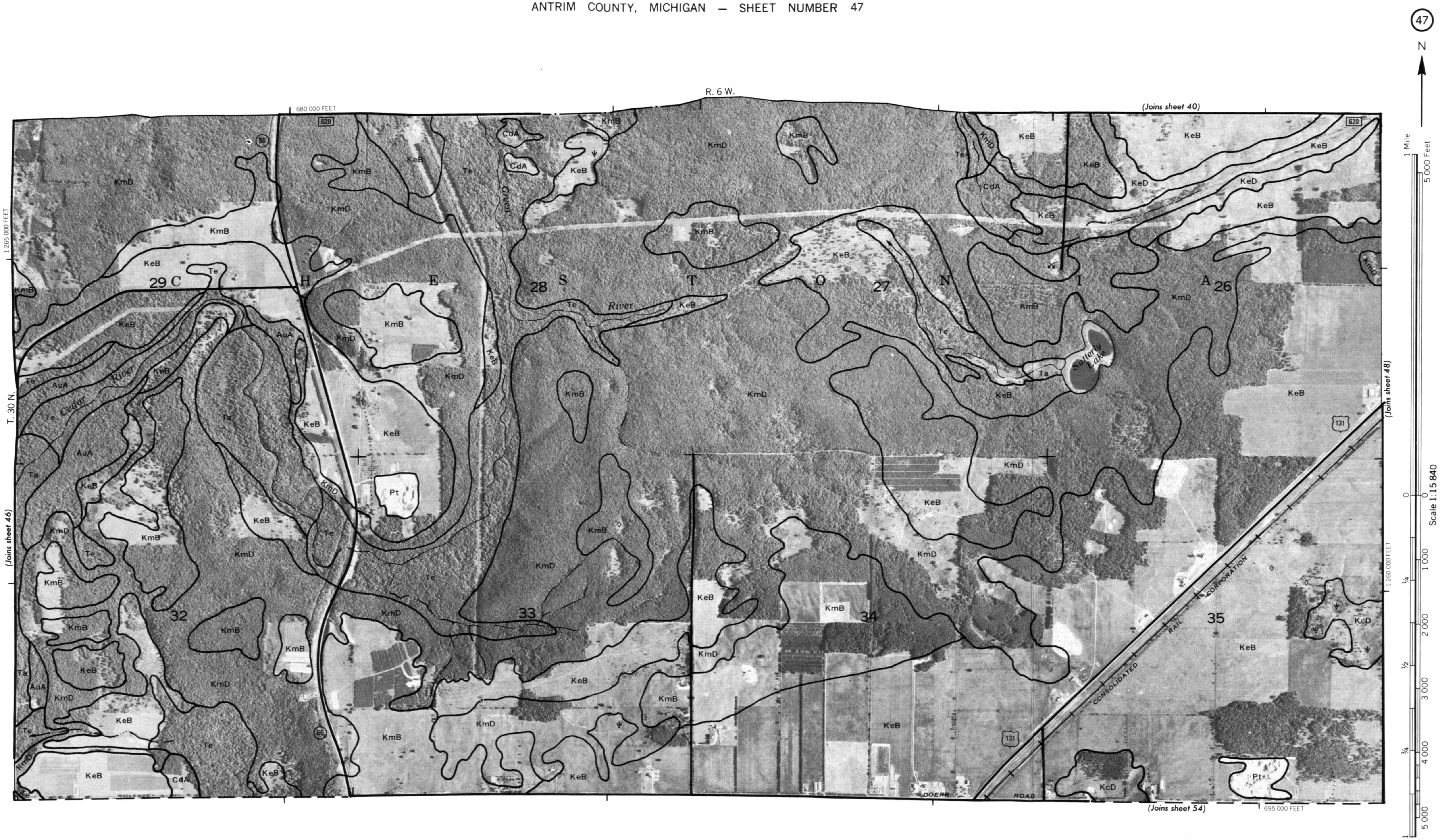
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 44

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

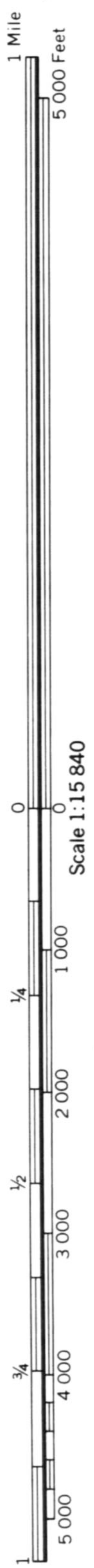
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 48

49

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

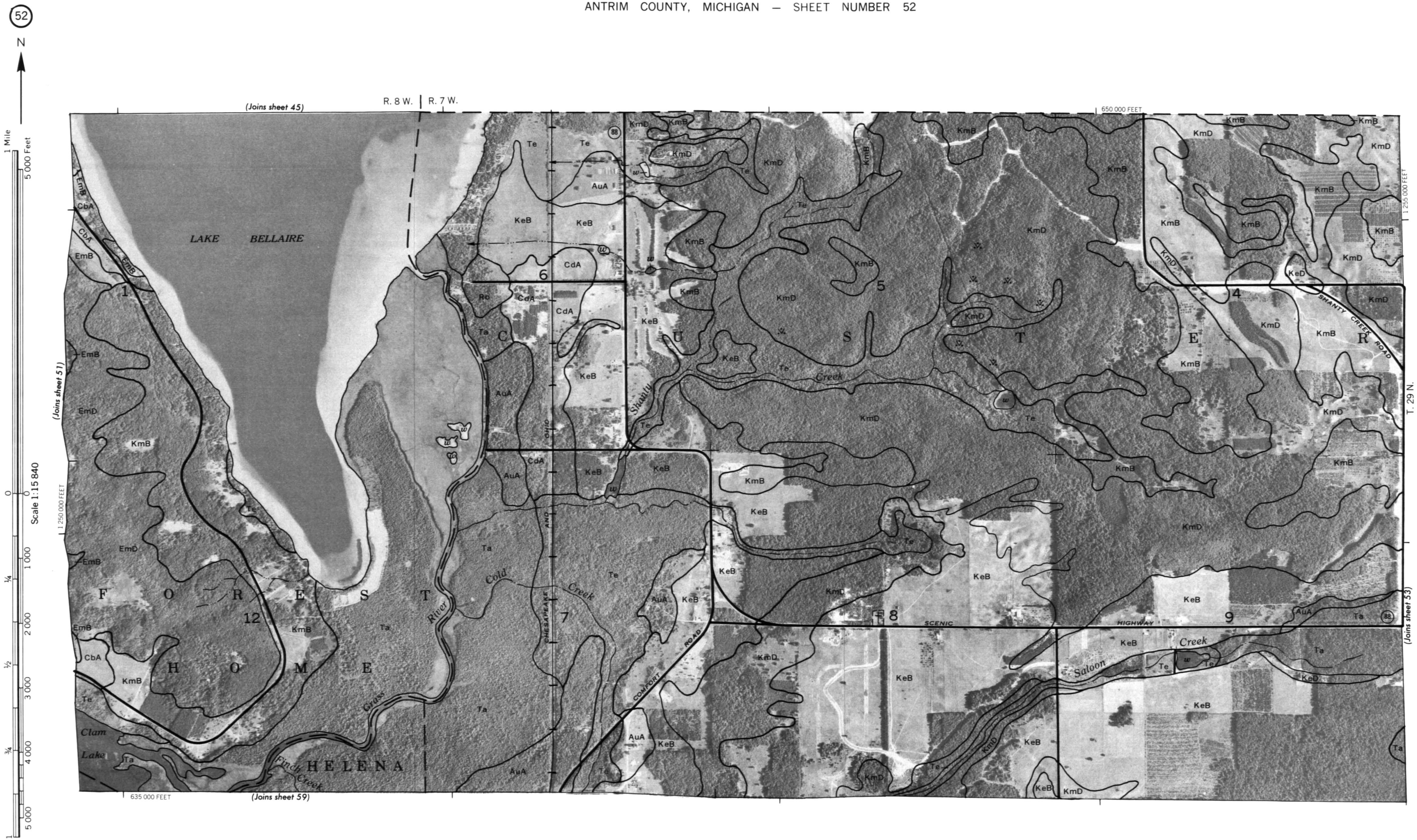
N



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 51

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

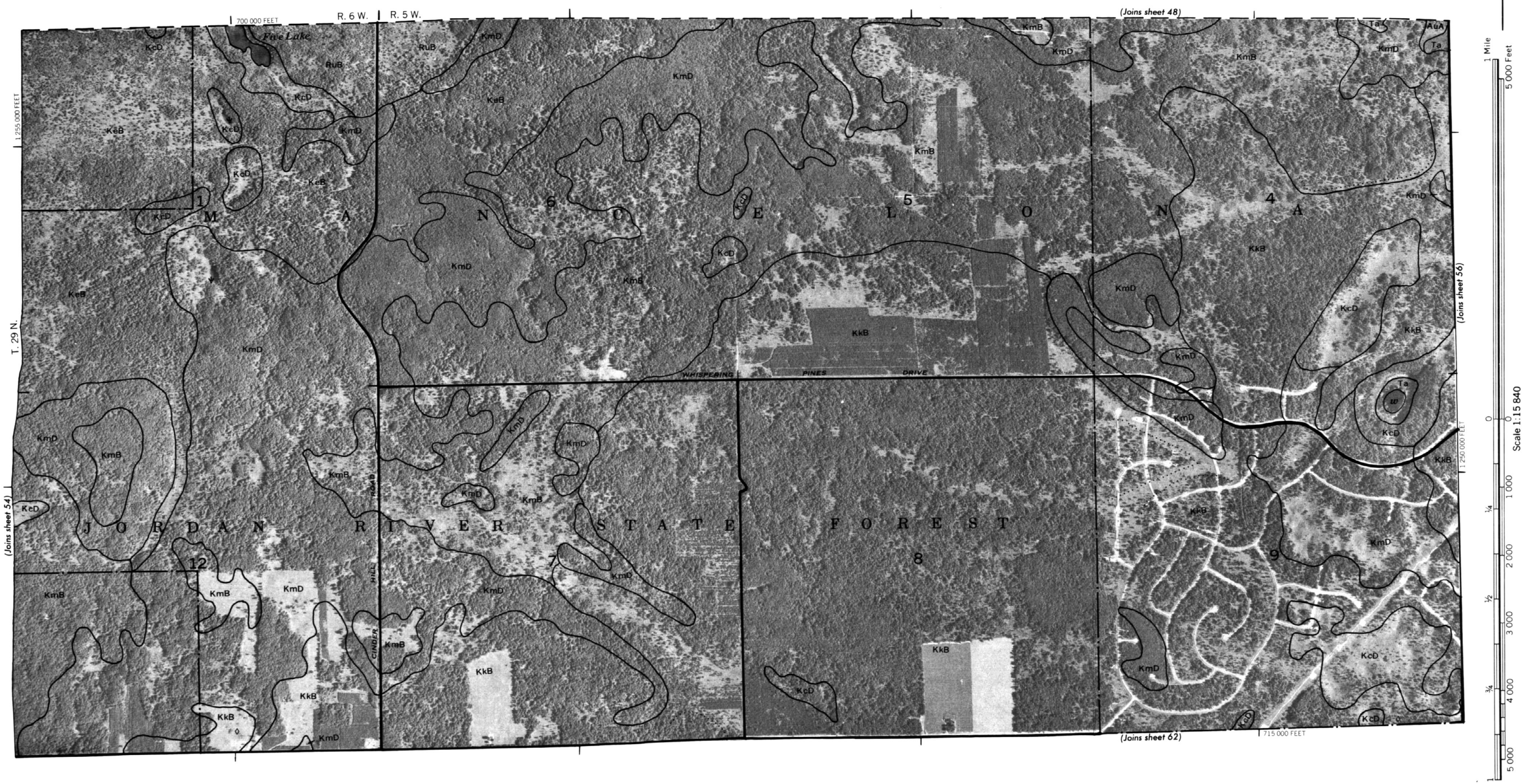
ANTRIM COUNTY, MICHIGAN NO. 52

ANTRIM COUNTY, MICHIGAN NO. 53

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 54



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

56

N

1 Mile

5 000 Feet

0

Scale 1:15 840

1 000

¼

2 000

½

3 000

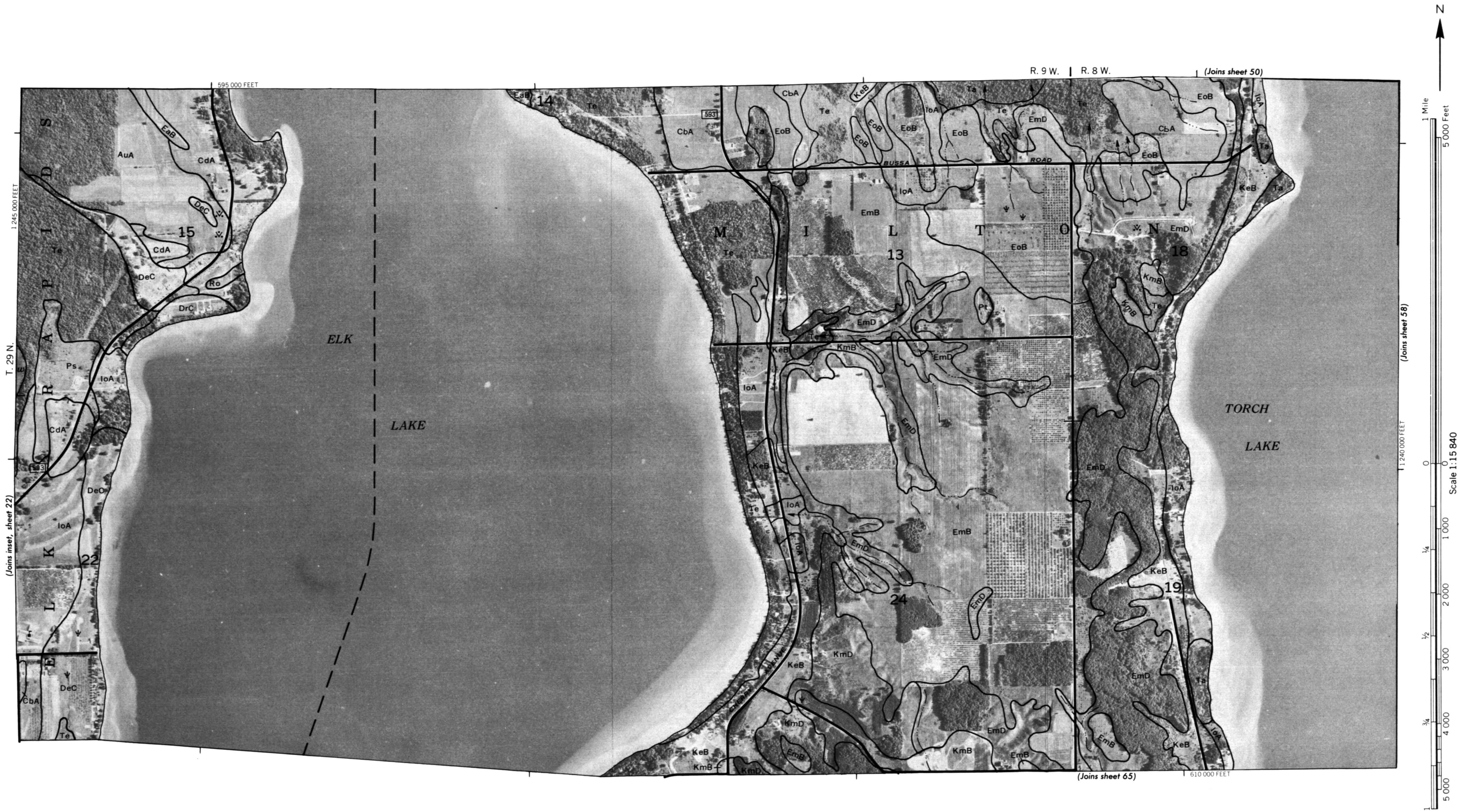
¾

4 000

1

5 000

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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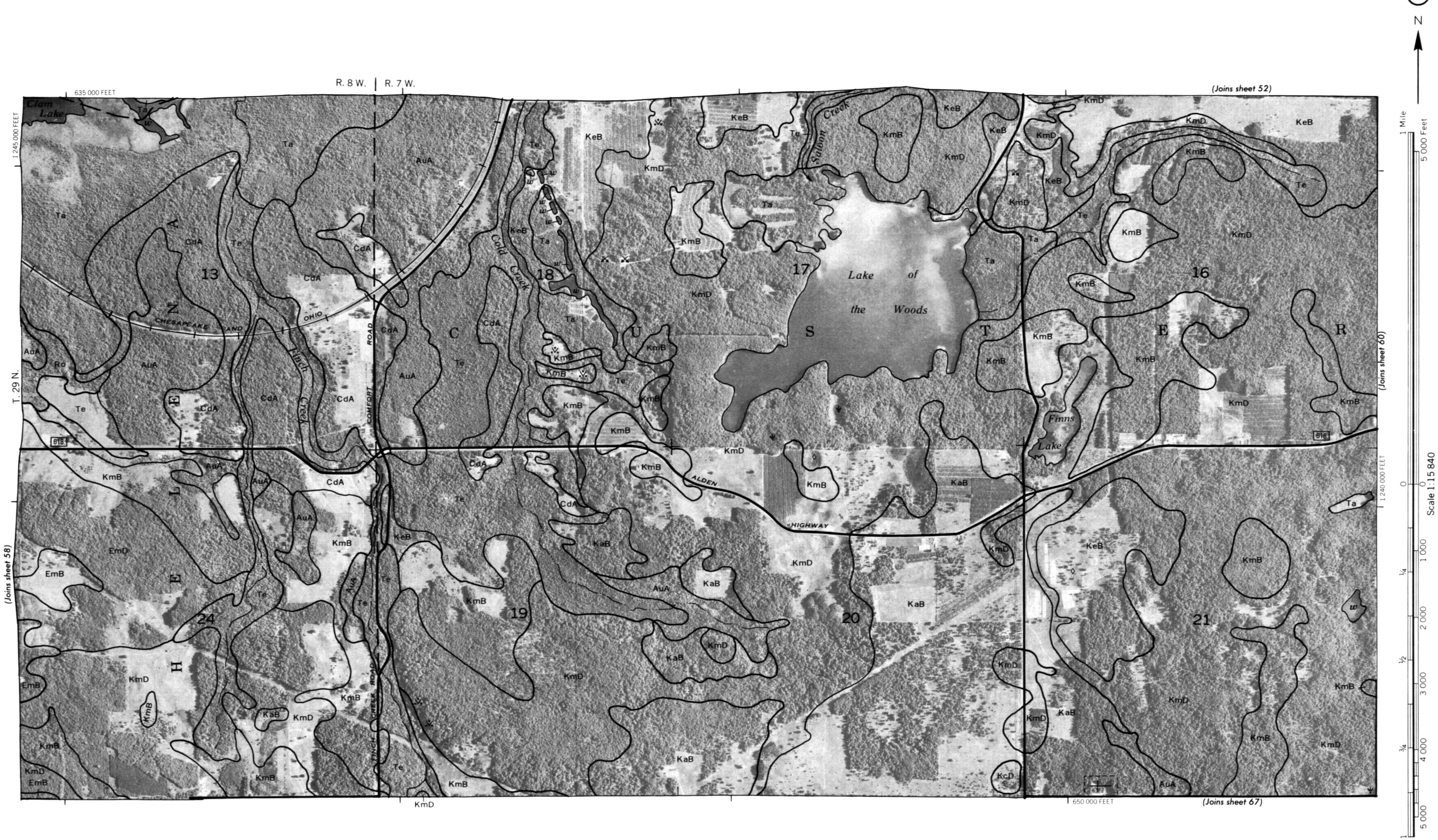
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 58



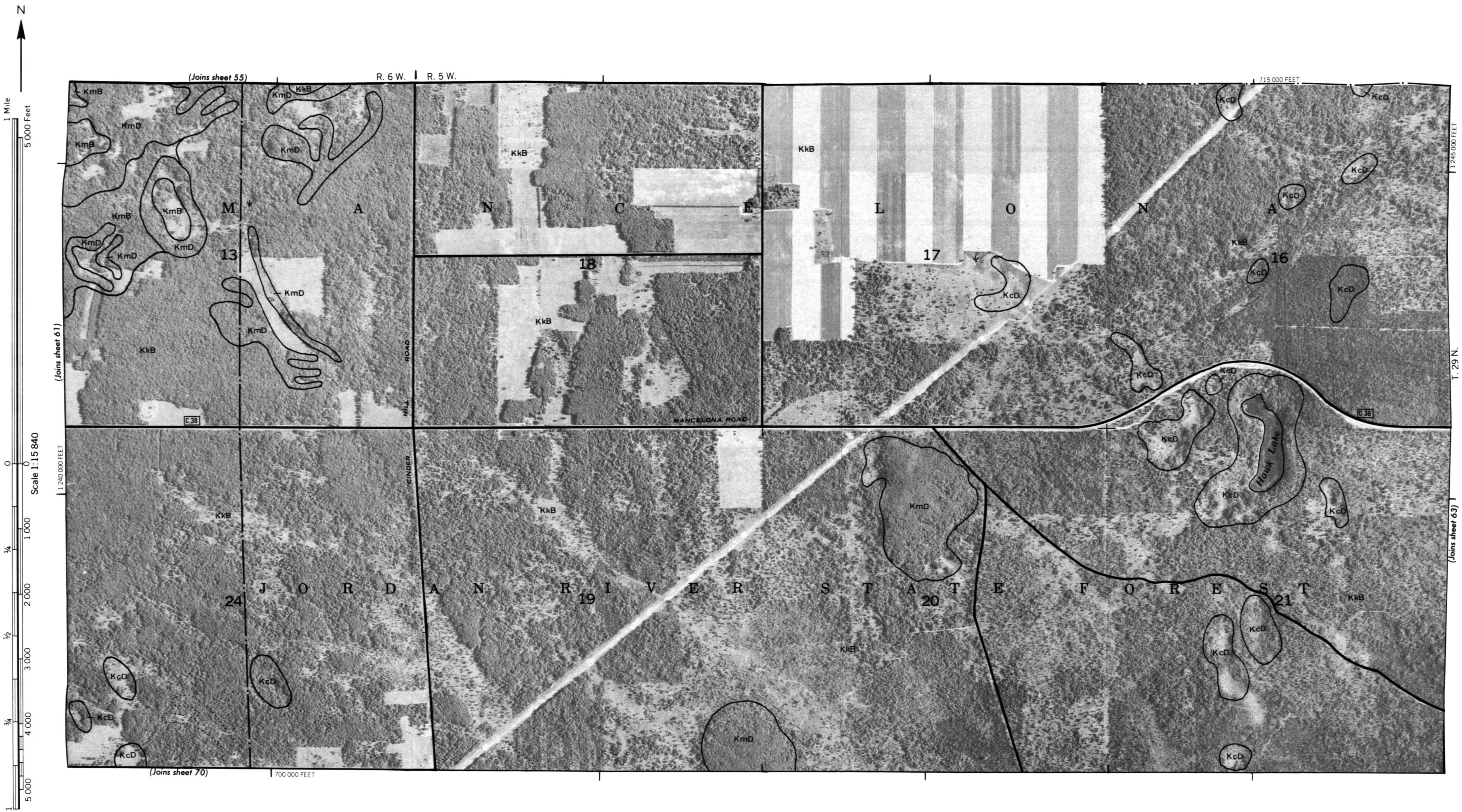
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 60

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

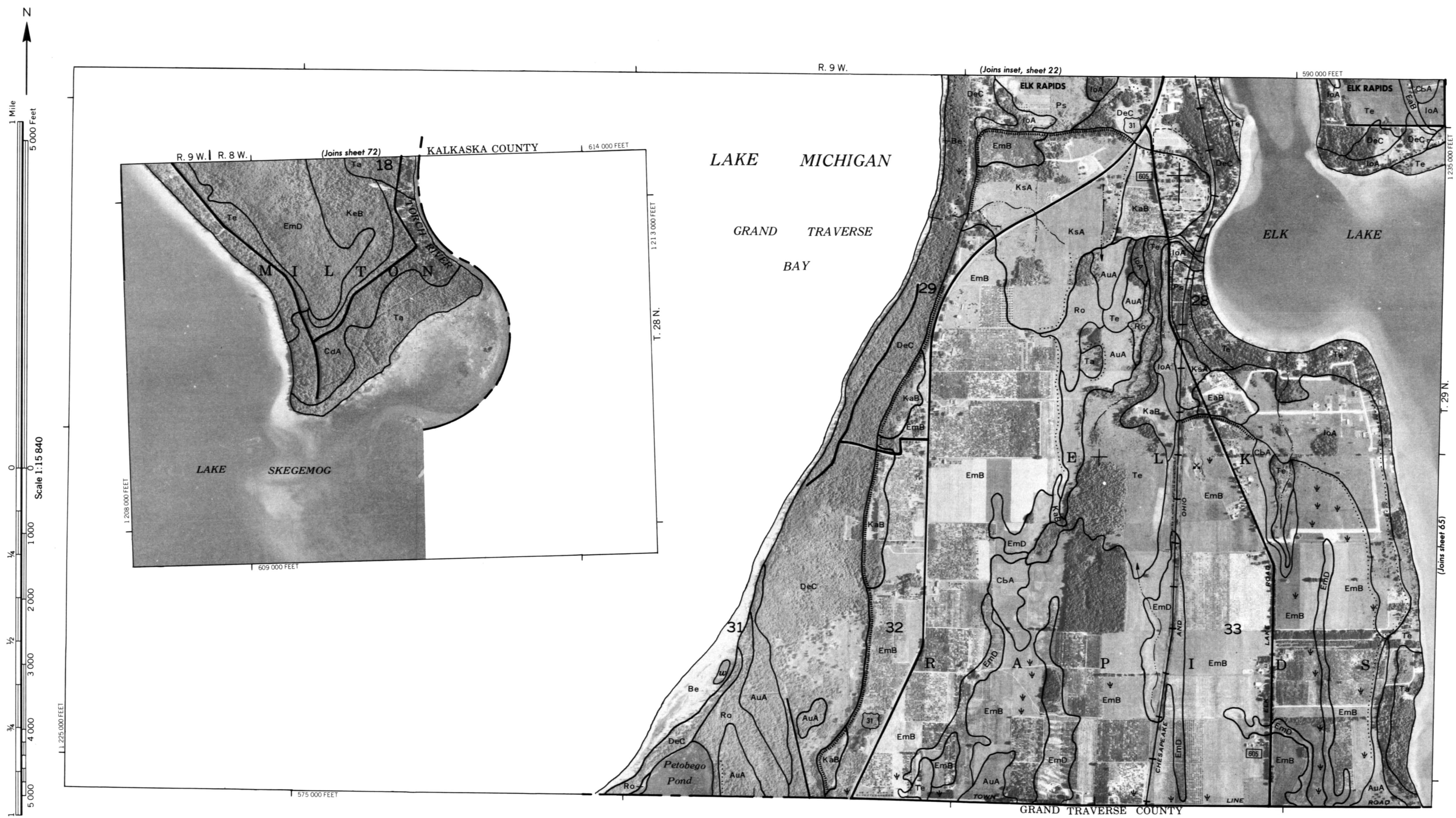
ANTRIM COUNTY, MICHIGAN NO. 60

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


63
N
720 000 FEET
R. 5 W.
(Joins sheet 56)
1 245 000 FEET
T. 23 N.
KmD
KkB
15
14
13
AIRSTRIP
RuB
Ta
Manistee
River
M A N C E L O N A
C 38
MANCELONA ROAD
OTSEGO COUNTY
KcD
J O R D A N R I V E R S T A T E F O R E S T
(Joins sheet 62)
22
23
24
BLUE LAKE ROAD
(Joins sheet 71)
735 000 FEET
1 240 000 FEET
1 Mile
5 000 Feet
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000
Scale 1:15 840
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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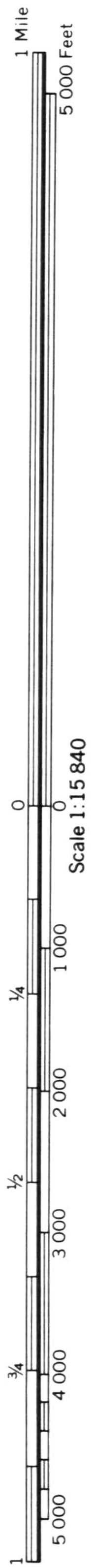
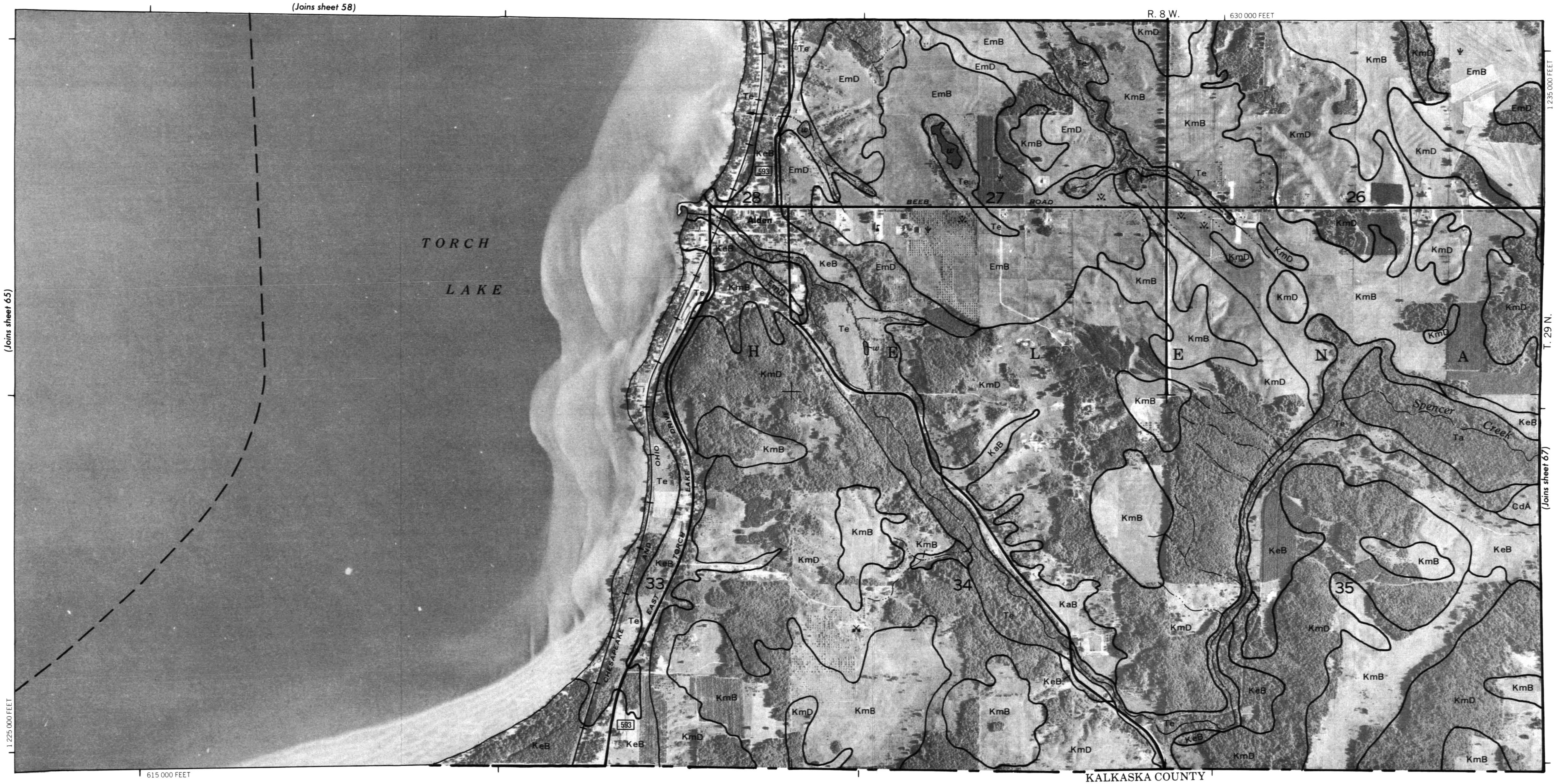
ANTRIM COUNTY, MICHIGAN — SHEET NUMBER 66

N

Scale 1:15 840





This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

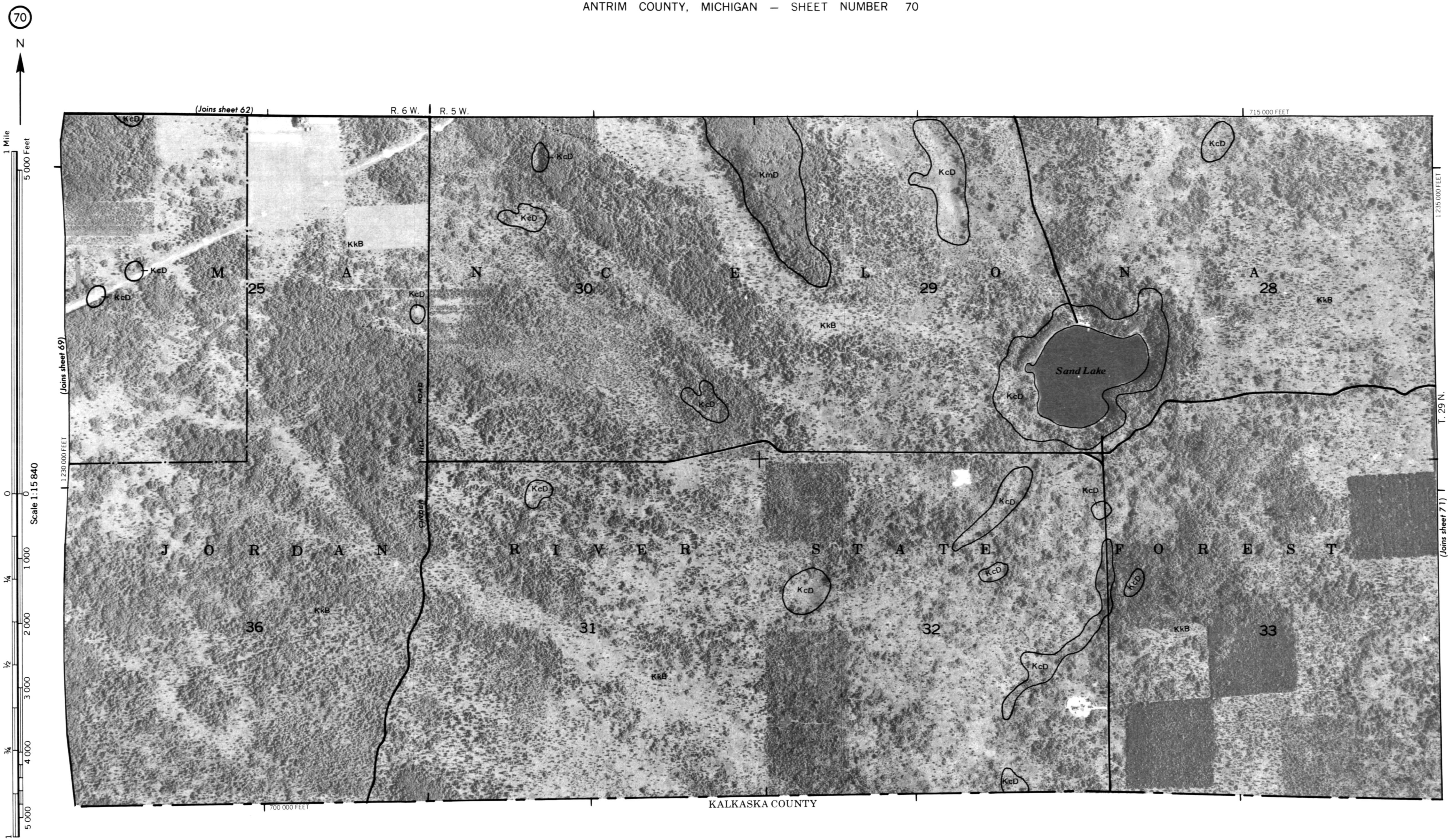
ANTRIM COUNTY, MICHIGAN NO. 66

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 68

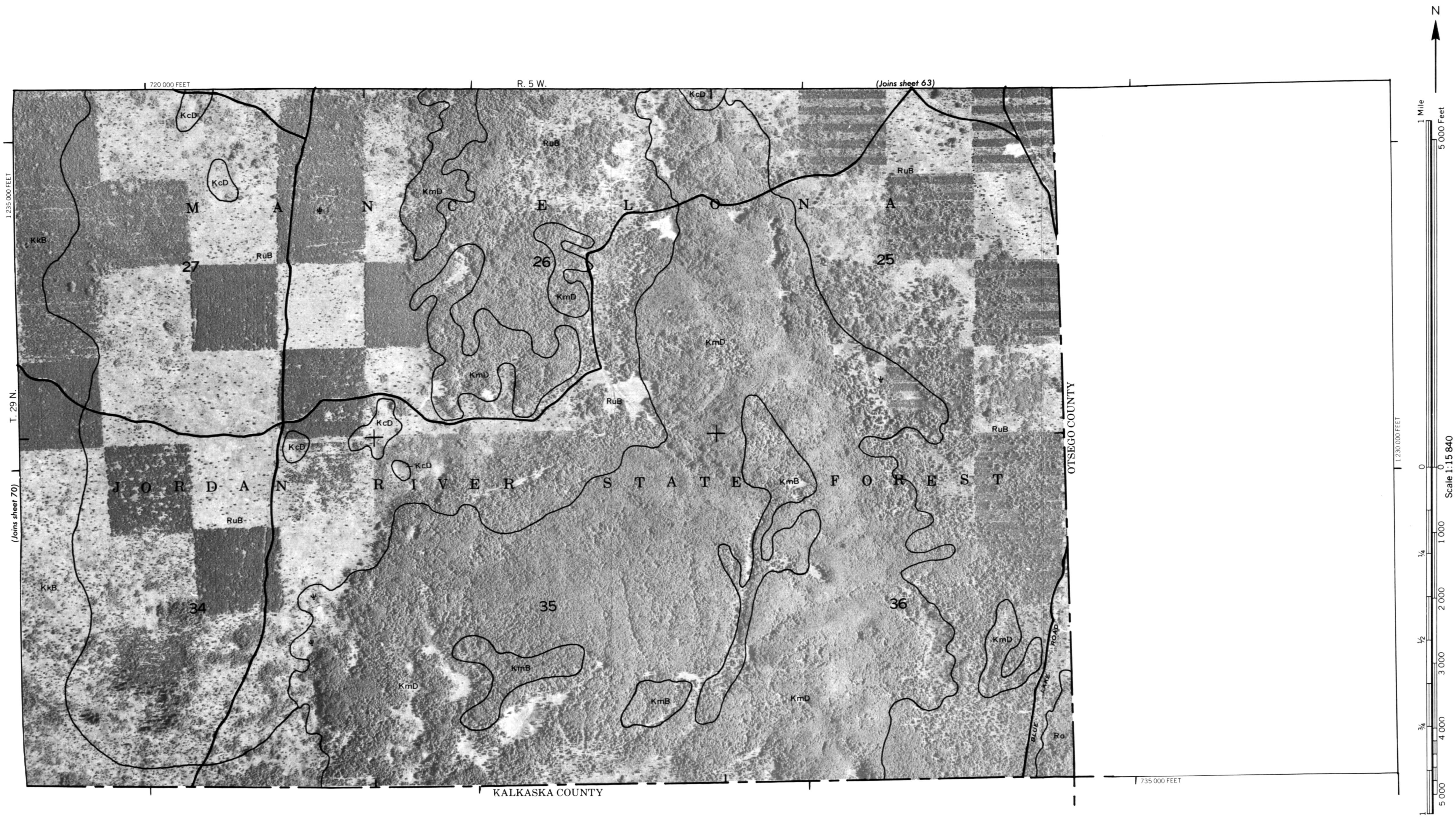
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



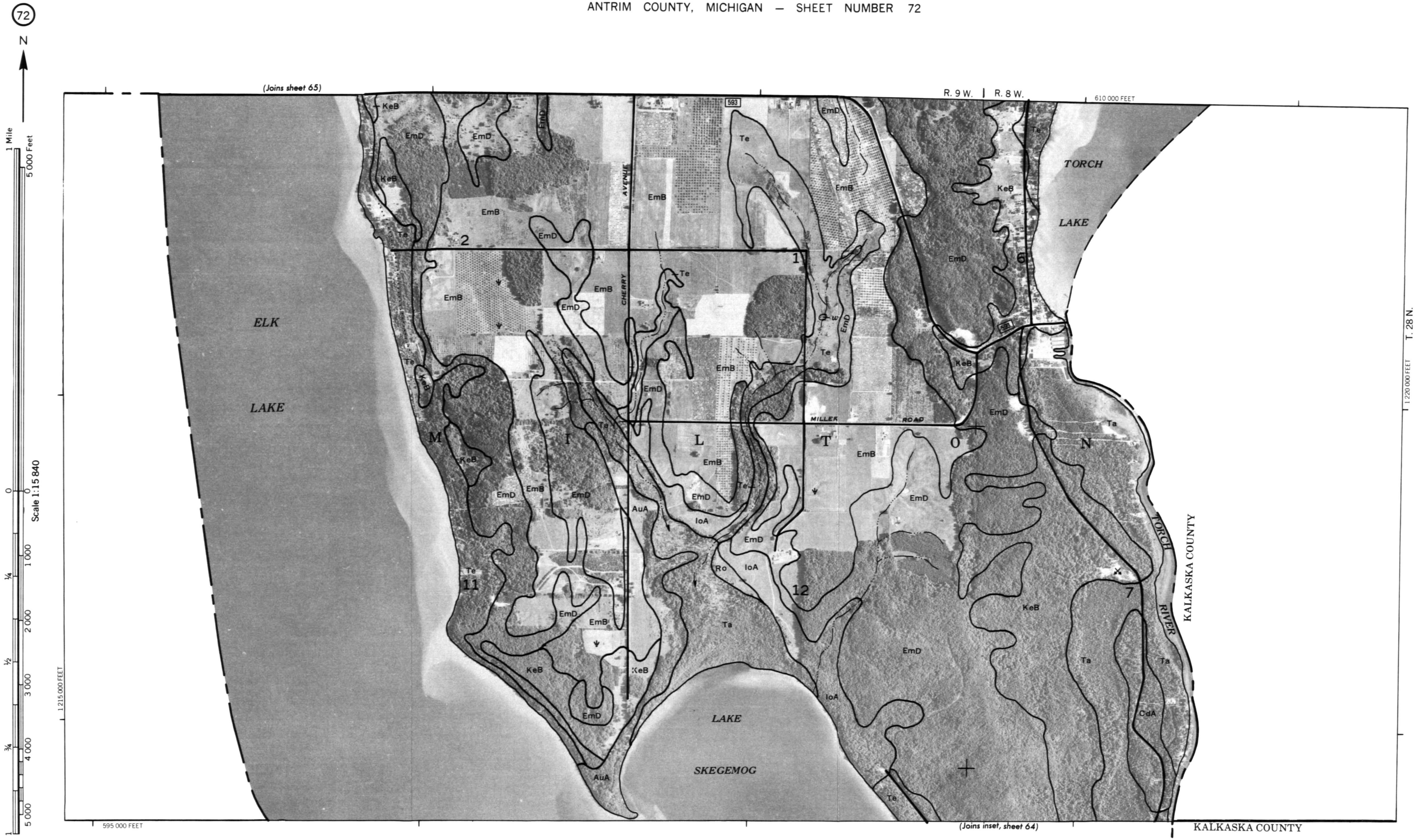
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 70

(71)



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ANTRIM COUNTY, MICHIGAN NO. 72